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RV COLLEGE OF ENGINEERING®

(Autonomous Institution affiliated to VTU)

IVSemester B. E. Fast Track ExaminationsJuly-19

Computer Science and Engineering

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 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 Consider two RE $r = 0*+1*$and$s = 01*+10*+1*0+(0*1)*$

i. Find a string in {0,1}* corresponding to neither r nor s.

ii. Find a string in {0,1}* corresponding to r and s — 01

1.2 Write ∈–NFA for the Regular Expression $((0+1)(0+1))*$. — 02

1.3 Find a RE corresponding to subsets of $\{0,1\}*$, whose second symbol from left and right end is same. — 01

1.4 Define left recursion. Eliminate left recursion from the following grammar:

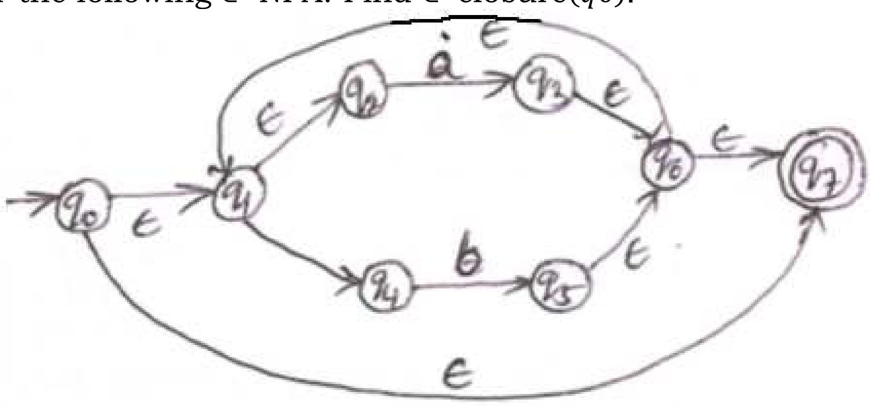
$$S \to (L)|x$$
$$L \to L, S|\ S$$
— 02

1.5 Transition Table of Turing machine is given below.

State q	*Input X*	*Move* $\delta(q, X)$
$q\ 0$	Δ	$(q\ 1, \Delta, R)$
$q\ 1$	A	$(q\ 2, a, R)$
$q\ 2$	B	$(q\ 3, b, R)$
$q\ 3$	A	$(q\ 3, a, R)$
$q\ 3$	Δ	$(q\ 4, \Delta, S)$

Define the language accepted by Turing machine assuming $q0$ as initial sate and $q4$ as final sate. — 01

1.6 Consider the following ∈–NFA. Find ∈-closure($q0$).



— 01

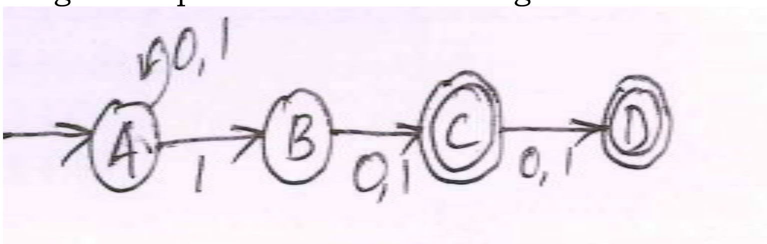
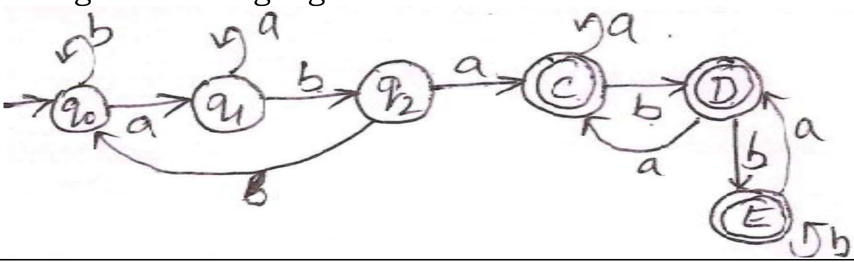
1.7 Differentiate recursive and recursively enumerable languages. — 02

1.8 For Σ={0,1}, design a Turing machine that accepts the language denoted by the regular expression $(a+b)*ab(a+b)*$. — 02

1.9 Define Context Sensitive Grammar. — 01

	1.10	CFLs are not closed under ________________ and ______________.	01
	1.11	Define inherently ambiguous grammar and give an example for inherently ambiguous language.	02
	1.12	Consider homomorphism h from alphabet $\{0,1,2\} to \{a,b\} defined\ by$ $h(0) = ab, h(1) = b\ and\ h(2) = aa.$ $Find\ h(0210), h(2201), h(1*02*)\ and\ h^{-1}(ababb).$	02
	1.13	Show a derivation tree for the string aabbbb with the grammar and describe the language generated by this grammar $S \rightarrow AB \mid \in$ $A \rightarrow aB,$ $B \rightarrow Sb.$	02

PART B

2	a	Discuss the applications of Regular Expressions with an example.	04
	b	Construct the regular expression from following automata: 	06
	c	Define distinguishable and indistinguishable states. Minimize the following automata using table filling algorithm. 	06

3	a	Define CFG. Construct a CFG for the following languages: i. $L = \{a^n b^m : n <= m + 3\}$ ii. $L = \{a^n W W^R b^n : W \in (a, b) *\}$	05
	b	Define CNF. Convert the following grammar into Chomsky Normal form: $S \rightarrow AB \mid aB$ $A \rightarrow aab \mid \in$ $B \rightarrow bbA$	06
	c	State and prove pumping lemma for regular languages.	05
		OR	
4	a	Remove all unit-productions, all useless productions, and all $\in$-productions from the grammar. Describe the language generated by the grammar. $S \rightarrow aA \mid aBB,$ $A \rightarrow aaA / \in,$ $B \rightarrow bB \mid bbC,$ $C \rightarrow B.$	05

	b	Define LMD,RMD and Ambiguous grammar. Show that the following grammar is ambiguous. Construct An unambiguous grammar equivalent to this grammar. $S \to AB\|aaB,$ $A \to a\|Aa,$ $B \to b.$	07
	c	Discuss the applications of Context Free Grammars	04

5	a	Discuss the languages accepted by PDA with an example for each	05
	b	Construct PDA that accept the language $L = \{N_a(w) = 2N_b(w)\}$on $\Sigma = \{a, b\}$	07
	c	Construct the NPDA corresponding to the grammar $S \to aABB\|aAA,$ $A \to aBB\|a,$ $B \to bBB\|A.$	04
		OR	
6	a	Consider the NPDA with transitions $\delta(q_0, a, Z) = \{(q0, AZ)\},$ $\delta(q_0, a, A) = \{(q0, A)\},$ $\delta(q_0, b, A) = \{(q1, \in)\},$ $\delta(q_1, \in, Z) = \{(q2, \in)\},$ using q0 as initial state and q2 as final state. Construct an equivalent CFG.	07
	b	Prove that CFLs are closed under Union, Concatenation and Closure.	05
	c	Show that the language L={WW|W ∈ (0,1)*} is not context free.	04

7	a	Define Linear Bounded Automata. Design a linear bounded automata to accept the language $L = \{a^n b^n c^n \| n >= 0\}$.	08
	b	Define left linear and right linear grammars. Construct right and left-linear grammar for the language $L = \{a^n b^m : n >= 2, m >= 3\}$. Construct DFA for both left and right linear grammars.	08

8	a	Define PCP. Given an instance of PCP, check whether this instance has a solution.	04
	b	If L_1 and L_2 are recursively enumerable languages over Σ, then prove that $L_1 \cap L_2$ and $L_1 \cup L_2$ are recursively enumerable.	06
	c	Define multi-dimensional TM. Discuss how Multi-dimensional TM can be simulated using standard single tape TM.	06

Table for 8a:

	List A	List B
i	Wi	Xi
1	110	110110
2	0011	00
3	0110	110