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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

IV Semester B. E. Examinations Nov/Dec-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	For $\sum = \{a, b\}$, construct dfa's that accept the sets consisting of all strings with no more than three a's.	02
	1.2	For $\sum = \{0,1\}$, give a regular expression r such that $L(r) = \{w \in \Sigma: w\ has\ atleast\ on\ pair\ of\ consecutive\ zones\}$.	01
	1.3	Consider two regular expressions $r = a^*b^*c^*$ and $s = c^*b^*a^*$. Find a string corresponds to r but not to s.	01
	1.4	Find the string of minimum length in $\sum = \{0,1\}$ in the language corresponding to the regular expression $(0+1)^r 000(0+1)^r$.	01
	1.5	Define CFG. What is the language generated by the CFG with the productions. $S \rightarrow ab/aSb$.	02
	1.6	Define rightmost derivation. Give rightmost derivation for the string. $id + id * id$ in the grammar with productions given below: $E \rightarrow E + E$ $E \rightarrow E * E$ $E \rightarrow (E)$ $E \rightarrow id$.	02
	1.7	Find the language generated by the CFG with productions: $S \rightarrow bS/aB$ $B \rightarrow bB/\varepsilon$.	01
	1.8	Define deterministic PDA.	01
	1.9	Give the transition diagram for PDA recognizing the language $L = \{wcw^R : w \in (a+b)^*\}$.	02
	1.10	Is the PDA $L = \{w: w \in \{a,b\}^*\ and\ \#_a(w) = \#_b(w)\}$ deterministic or not. State whether it is $DPDA$ or not with a valid reason.	02
	1.11	Identify useless variables in one CFG below: $S \rightarrow aA\|bB$ $A \rightarrow aA\|a$ $B \rightarrow bB$ $D \rightarrow ab\|Ea$ $E \rightarrow aC\|d$.	02
	1.12	Recursively enumerable languages are also called as _________.	01
	1.13	Obtain Turing machine to accept the language L, set of all strings over $\{0,1\}$ ending with 010.	02

PART B

2 a Define regular expressions. Give regular expression which generates the following languages over one alphabet $\sum = \{a, b\}$.

i) Strings of $a's$ and $b's$ having length 2.

ii) Strings of $a's$ and $b's$ starting with a and ending with b. — 06

b Convert the following NFA shown in Fig. 2b to its equivalent DFA.

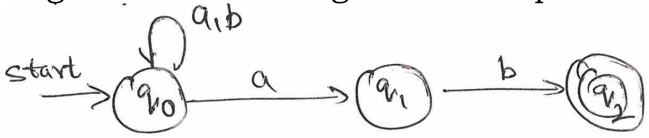

Fig. 2b — 06

c Find a minimum state DFA, for the given transition table by using table filling algorithm.

	δ	0	1
→	A	B	A
	B	A	C
	C	D	B
*	D	D	A
	E	D	F
	F	G	E
	G	F	G
	H	G	D

04

3 a State and prove Pumping lemma for regular languages. — 05

b Show that language $L = \{a^n b^n | n \geq 0\}$ is not regular. — 05

c Let M_1 and M_2 are the $DFAs$ as shown in Fig 3c below accepting languages L_1 and L_2 respectively. Draw $DFAs$ accepting the following languages:

i) $L_1 \cap L_2$

ii) $L_1 - L_2$

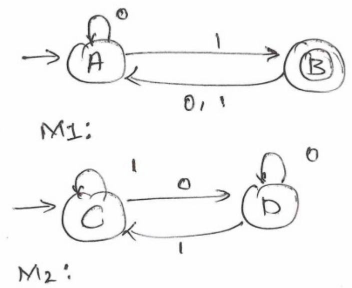

Fig. 3c — 06

OR

4 a Construct CFG to generate the following languages:

i) $L = \{a^i b^j : 2i = 3j + 1\}$

ii) $L = \{w \in \{a, b\}^* : w = w^R\}$

iii) $L = \{w \in \{a, b\}^* : every\ prefix\ of\ w\ has\ atleast\ as\ many\ a's\ as\ b's\}$ — 06

b Given grammar G, for the string $aaabbabbba$, find:

i) LMD

ii) RMD

iii) Parse tree.

$S \to aB|bA$

$A \to a|aS|bAA$

$B \to b|bS|aBB$ — 06

c Covert the following grammar into CNF

$S \to 0A|1B$

$A \to 0AA|1S|1$

$B \to 1BB|0S|0.$ — 04

5	a	Obtain a PDA to accept the language $L = \{wcw^R \| w \in \{a,b\}^*\}$ by a final state and show the string accepting and rejecting.	06
	b	Obtain a CFG for the PDA shown below: $S(q_0, a, Z) = (q_0, AZ)$ $S(q_0, a, A) = (q_0, A)$ $S(q_0, b, A) = (q_1, \varepsilon)$ $S(q_1, \varepsilon, Z) = (q_2, \varepsilon)$.	06
	c	Covert the CFG into its equivalent PDA: $E \to E + T$ $E \to T$ $T \to T * F$ $T \to F$ $F \to (E)$ $F \to id$.	04
		OR	
6	a	State and prove Pumping lemma for $CFLs$.	04
	b	Prove that $L = \{wcw : w \in \{a,b\}^*\}$ is not context free.	04
	c	List out the closure properties of context-free languages and explain any two. 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 $L_1 \cap L_2$ is not context free.	08
7	a	Define regular grammar. Write the right linear grammar to accept the following languages. $L = \{w : \|w\| mod 3 > 0 \; where \; w \in \{a\}^*\}$ $L = \{w \in \{a,b\}^* : \|w\| \; is \; even\}$	06
	b	Define context sensitive grammar. Write grammar to generate the language $L = \{a^n b^n c^n \| n \geq 1\}$. Show that the string $aaabbbccc$ is generated.	06
	c	Define linear bounded automata. Construct LBA to accept the language. $L = \{a^n b^n \| n \geq 1\}$.	04
8	a	Define Turing Machine. Design TM to accept the language $L = \{w \| w \in (0+1)^* \; containing \; the \; substring \; 001\}$.	06
	b	Does the post correspondence problem with two lists $x = (b, bab^3, ba)$ and $y = (b^3, ba, a)$ have a solution?	04
	c	Define multi-dimensional TM. Discuss how multi-dimensional TM can be simulated using standard Turing Machine.	06