**16CS46**

**USN** | | | | | | | | | | |

# RV COLLEGE OF ENGINEERING®
**(An Autonomous Institution affiliated to VTU)**
**IV Semester B. E. Examinations April/May-19**
## Computer Science and Engineering
## THEORY OF COMPUTATIONS

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

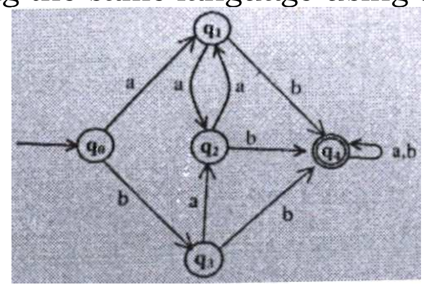
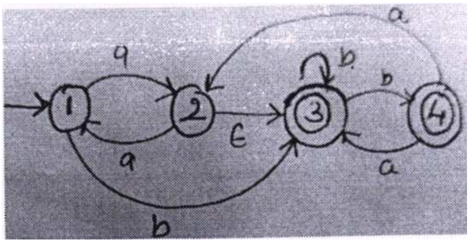
***Instructions to candidates:***

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 | What is minimum number of state a deterministic finite automation requires to accept the language $L = \{w \mid w \in \{0,1\}*$, number of $0s$ and $1s$ in $w$ are divisible by 3 and 5, respectively$\}$. | 02 |
| | 1.2 | Identify the shortest string and its length $NOT$ in the language over $\Sigma = \{a, b\}$ of the following regular expression. | 02 |
| | 1.3 | What is the equivalent left linear grammar for the following given right linear grammar: $S \to abA \mid bB \mid aba, A \to b \mid aB \mid bA, B \to aB \mid aA$ | 02 |
| | 1.4 | Consider the context free grammars over the alphabet $\{a, b\}$ given below, where S is non – terminal<br>$X: S = aSa \mid aSb \mid \varepsilon$<br>$Y: S = aaS \mid bbS \mid \varepsilon$<br>What is the length of the shortest string which does not belongs to $L(X)$ but belongs to $L(Y)$. | 02 |
| | 1.5 | Consider the $CFG$<br>$S \to XX$<br>$X \to XXX/bX/Xb/a$<br>Construct the parse tree and $LMD$ for the string "$bbaaaab$". | 02 |
| | 1.6 | For the $DFA$ given by transition table below, find its equivalent linear grammar. Here, $A$ is the starting and $D$ is final state.<br><br>| | $a$ | $b$ |<br>| $A$ | $B$ | $D$ |<br>| $B$ | $A$ | $C$ |<br>| $C$ | $D$ | $B$ |<br>| $D$ | $C$ | $A$ | | 02 |
| | 1.7 | Write Chomsky hierarchy for formal languages. | 02 |
| | 1.8 | Design a turing machine to increment a unary number where $w \in \{0\}^+$. | 02 |
| | 1.9 | Mention the Transition function for $TM$ with stay option. | 01 |
| | 1.10 | Differentiate recursively enumerable language and recursive languages. | 02 |
| | 1.11 | Consider homomorphism $h$ from alphabet $\{0, 1, 2\}$ to $\{a, b\}$ defined by $h(0) = ab, h(1) = b$ and $h(2) = aa$. Find $h(0210)$ and $h^{-1}(ababb)$. | 01 |

## PART B

| | | | |
|---|---|---|---|
| 2 | a | Define regular expressions. Give regular expression which generates the following languages over the alphabet $\Sigma = \{0, 1\}$.<br>i) Strings of a's and b's ending with b and has no substring $aa$.<br>ii) Strings that do not end with 01. | 05 |
| | b | For the $DFA$ shown in fig 2b, use the minimization algorithm to find a minimum $DFA$ recognizing the same language using table filling algorithm.<br><br>Fig 2b | 06 |
| | c | Obtain a regular expression for the $FA$ shown fig 2c using state elimination method.<br><br>Fig 2c | 05 |
| | | | |
| 3 | a | Convert the following grammar into $GNF$: $S \rightarrow AA\|0, A \rightarrow SS\|1$. | 06 |
| | b | Define a $CFG$ and write a $CFG$ for the language<br>$L = \{a^n b^n c^m d^m \| n \geq 1, m \geq 1\} \cup \{a^n b^m c^m d^n, n \geq 1, m \geq 1\}$ | 05 |
| | c | Describe the decision algorithms to answer the following questions:<br>i) Given two finite automata $M_1$ and $M_2$, are there any strings that are accepted by both?<br>ii) Given a $FAM$, is it a minimum state $FA$ accepting the language $L\,(M)$? | 05 |
| | | **OR** | |
| 4 | a | Convert the following grammar into $CNF$: $S \rightarrow AB\|aB, A \rightarrow aab\| \in, B \rightarrow bbA$. | 04 |
| | b | Using Pumping lemma for regular sets show that $L = \{a^n b^n \| n \geq 0\}$ is not regular. | 04 |
| | c | Define ambiguity in grammar. Is the following grammar ambiguous? Justify your answer : $S \rightarrow iCtS\|iCtSeS\|a, C \rightarrow b$ | 04 |
| | d | Show that the regular languages are closed under complement operation. | 04 |
| | | | |
| 5 | a | Define push down automata and instantaneous description ($ID$). Construct a $PDA$ to accept the language $L = \{w \| w \in (a, b)^* and\ n_a(w) = n_b(w)\}$ by a final state and show by $ID$ that the string $abbaa$ is accepted. | 07 |
| | b | If $L_1$ is $CFL$ and $L_2$ is regular language, then prove that $L_1 \cap L_2$ is a $CFL$. | 04 |
| | c | Convert the given $CFG$ to its equivalent $PDA$.<br>$S \rightarrow aABB\|aAA, A \rightarrow aBB\|a, B \rightarrow bBB\|A, C \rightarrow a$ | 05 |
| | | **OR** | |

| | | | |
|---|---|---|---|
| 6 | a | State and prove pumping lemma for $CFL$. Show that $L = \{a^a b^n c^n \mid n \geq 0\}$ is not $CFL$. | 06 |
| | b | Define the language accepted by $PDA$ by final state and by empty stack. | 04 |
| | c | Find the equivalent $CFG$ for the $PDA$ given below $\delta(q_0, a, z_0) = \{(q_0, AZ_0)\}, \delta(q_0 a, A) = \{(q_0, AA)\}, \delta(q_0, b, A) = \{(q_1, \varepsilon)\}$, $\delta(q_1, b, A) = \{(q_1, \varepsilon)\}, \delta(q_1, \varepsilon, Z_0) = \{(q_2, Z_0)\}$. | 06 |
| | | | |
| 7 | a | Obtain the left linear grammar for the $DFA$ given below. | |

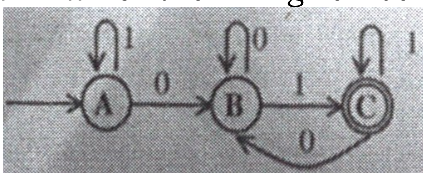



Fig 7a

| | | | |
|---|---|---|---|
| | | | 04 |
| | b | Obtain a right linear grammar for the language $L = \{a^n b^n \mid n \geq 2, m \geq 3\}$. | 04 |
| | c | Define context sensitive grammar. Give context sensitive grammar to generate the language $L = \{a^n b^n c^n \mid n \geq 1\}$. Show that the string "$aaabbbccc$" is generated. | 04 |
| | d | Construct a $DFA$ to accept the language generated by the following grammar: $S \to aA \mid \varepsilon, A \to aA \mid bB \mid \varepsilon, B \to bB \mid \varepsilon$. | 04 |
| | | | |
| 8 | a | Define post correspondence problem. Solve the $PCP$ given below. | 04 |

| | List A | List B |
|---|---|---|
| $i$ | $w_i$ | $x_i$ |
| 1 | 1 | 111 |
| 2 | 10111 | 10 |
| 3 | 10 | 0 |

| | | | |
|---|---|---|---|
| | b | If $L_1$ and $L_2$ are recursively enumerable languages over $\Sigma$, then prove that $L_1 \cap L_2$ and $L_1 \cup L_2$ are recursively enumerable. | 06 |
| | c | During Turing machine and language of $TM$. Design a $TM$ to perform $x + y$ where $x$ and $y$ are two positive integers. | 06 |