



**B.E/B.TECH DEGREE EXAMINATIONS: APRIL /MAY 2024**

(Regulation 2018)

Fourth Semester

**COMPUTER SCIENCE AND ENGINEERING**

U18CST4003: Theory of Computation

**COURSE OUTCOMES**

- CO1: Design or convert an automaton for any given problem and experiment and document using JFLAP tool.
- CO2: List the various closure properties of languages in Chomsky hierarchy.
- CO3: Construct Context Free Grammars to generate strings from a context free language and convert them into normal forms.
- CO4: Identify the hierarchy of formal languages, grammars and machines.
- CO5: Distinguish between computability and non-computability; decidability and undecidability.

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 2 = 20 Marks)**

**(Answer not more than 40 words)**

1. State the differences in Non deterministic finite automata with that of Deterministic finite automata. CO4 [K<sub>3</sub>]
2. Design a DFA for  $L(M) = \{a^n b \mid n \geq 0\}$ . CO1 [K<sub>5</sub>]
3. Does minimization possible for the following finite automata? If not, justify with reasons. CO4 [K<sub>3</sub>]

(Note:  $\rightarrow$  indicates start state and \* indicates final state)

States	x	Y
$\rightarrow q_0$	$q_1$	$q_1$
$q_1$	$q_2$	$q_3$
* $q_2$	$q_2$	$q_3$
* $q_3$	$\Phi$	$q_3$
$\Phi$	$\Phi$	$\Phi$

4. State the steps in eliminating  $\epsilon$  – transitions of  $\epsilon$ - NFA to DFA. CO4 [K<sub>3</sub>]
5. Prove that the CFG with productions  $S \rightarrow 0S1S \mid 1S0S \mid \epsilon$  generates the CO4 [K<sub>3</sub>]

Language,  $L = \{ x \in \{0,1\}^* \mid n_0(x) = n_1(x) \}$

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|-----|---|-----|-------------------|
| 6.  | Construct a CFG for the language that consists of balanced parenthesis. Assume any two symbols of parenthesis.  | CO3 | [K <sub>3</sub> ] |
| 7.  | List any four assumptions of Turing computability.  | CO5 | [K <sub>4</sub> ] |
| 8.  | State the configuration of Multidimensional and Multitape Turing Machine.   | CO5 | [K <sub>4</sub> ] |
| 9.  | Define recursive language.  | CO4 | [K <sub>3</sub> ] |
| 10. | Is Post Correspondence Problem (PCP) an undecidable problem? Does the following list have a solution in PCP? Justify.<br>$\alpha = (10, 01, 0, 100, 1)$<br>$\beta = (101, 100, 10, 0, 010)$ | CO5 | [K <sub>3</sub> ] |

**Answer any FIVE Questions:-**

**PART B (5 x 16 = 80 Marks)**

**(Answer not more than 400 words)**

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|-----|--|----|-----|-------------------|
| 11. | a) Design a DFA that accepts an odd number of 1's on $\{0,1\}$ stating the rules with explanation.   | 10 | CO1 | [K <sub>3</sub> ] |
|     | b) Trace for a string acceptance and rejection for the Q.11. a)  | 6  | CO3 | [K <sub>3</sub> ] |
| 12. | a) Design a NFA to recognize the regular expression $(0+1)(0+1)^*(0+1)$ using Thomson construction algorithm and convert to an equivalent minimized DFA. Trace for a string $w = 0001$ .           | 8  | CO1 | [K <sub>5</sub> ] |
|     | b) Consider the two regular expressions.<br>$r = 0^* + 1^*$ $s = 01^* + 10^* + 1^*0$   | 8  | CO4 | [K <sub>3</sub> ] |
|     | i) Find a string corresponding to r but not to s.  |    |     |                   |
|     | ii) Find a string corresponding to s but not to r.   |    |     |                   |
|     | iii) Find a string corresponding to both r and s.  |    |     |                   |
|     | iv) Find a string in $\{0,1\}^*$ corresponding to neither r nor s  |    |     |                   |
| 13. | a) State the properties that are closed under context free languages. What is pumping lemma in Context Free Language? Show that the language $L = \{ a^n b^j \mid n = j^2 \}$ is not context free. | 6  | CO2 | [K <sub>4</sub> ] |

- b) Consider the following CFG  $G$  with productions stated and Convert to the two normal form:  $S \rightarrow AB$        $A \rightarrow aAA \mid \epsilon$      $B \rightarrow bBB \mid \epsilon$     10    CO2    [K4]
14. a) Construct a Turing Machine for the following language.    8    CO1    [K5]  
 $L(T) = \{0^n 10^n \mid n \geq 0\}$
- b) Prove the theorems. 1) Let  $L_1, L_2$  and  $L_3$  be languages over  $\Sigma$ . If  $L_1 \leq L_2$  and  $L_2 \leq L_3$ , then  $L_1 \leq L_3$ .    8    CO5    [K4]  
2) If  $L_2$  is recursive, and  $L_1 \leq L_2$ , then  $L_1$  is also recursive.
15. a) Give the Rice's Theorem and prove the same.    8    CO5    [K4]  
b) State and brief on Church Turing Thesis and Give what cannot be computed by TM with example? Is halting problem undecidable? Justify    8    CO4    [K3]
16. a) Consider the language  $L = \{a^n b^m c^p d^q \mid m + n = p + q\}$ , Design a Push Down Automata for the above language.    12    CO4    [K5]  
b) State the theorem stating the equivalence of CFG and PDA and its proof.    4    CO2    [K3]

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