



B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2023

(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. Design the DFA accepting the language over the alphabet 0, 1 that has a set of all strings that begin with 1 and end with 0. | CO1 | [K ₃] |
| 2. Define NFA with ϵ -transition. | CO1 | [K ₁] |
| 3. Show that whether $L = \{a^{2^n} n \geq 1\}$ is regular? | CO2 | [K ₂] |
| 4. Construct NFA equivalent to the regular expression: $b + ba^*$ | CO2 | [K ₃] |
| 5. Write down the language generated by the grammar $G = (V, T, P, S)$ where $P = \{S \rightarrow aSb, S \rightarrow \epsilon\}$ | CO3 | [K ₃] |
| 6. Construct CFG to generate $\{a^n b^n n \in \mathbb{Z}^+\}$ | CO3 | [K ₃] |
| 7. Design a Turing machine with no more than three states that accepts the language $a(a+b)^*$. Assume $\Sigma = \{a, b\}$ | CO4 | [K ₃] |
| 8. What is a Multi-Tape Turing Machine? | CO4 | [K ₁] |
| 9. What is the difference between PCP and MPCP? | CO5 | [K ₁] |
| 10. Show that union of recursive language is recursive. | CO5 | [K ₂] |

Answer any FIVE Questions:-

PART B (5 x 16 = 80 Marks)

(Answer not more than 400 words)

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|--------|--|----|-----|-------------------|
| 11. a) | Prove that $1^2 + 2^2 + 3^2 + \dots + n^2 = \sum n^2 = (n(n+1)(2n+1))/6$. | 6 | CO1 | [K ₂] |
| b) | Construct DFA for the equivalent NFA $M = (\Sigma, Q, \delta, q_0, F)$ $\Sigma = \{0, 1\}$, $Q = \{q_0, q_1, q_2, q_3\}$, $F = \{q_3\}$, where δ is defined as | 10 | CO1 | [K ₃] |

| | | |
|-------|----------------|----------|
| | 0 | 1 |
| q_0 | $\{q_0, q_1\}$ | q_0 |

| | | |
|-----------------|----------------|----------------|
| q ₁ | q ₂ | q ₁ |
| q ₂ | q ₃ | q ₃ |
| *q ₃ | | q ₂ |

12. a) Using pumping lemma for the regular sets, prove that the following language is not regular. 8 CO2 [K₂]
 $L = \{ww^R \mid w \in \{0,1\}^*\}$
- b) Construct NFA with ϵ equivalent to (i) $(00 + 1)^* 1 (0 + 1)$ 8 CO2 [K₃]
(ii) $(a^*|b^*)^*$
13. a) Construct a PDA accepting the following language $L = \{a^n b^m a^n \mid m, n \geq 1\}$. 8 CO3 [K₃]
- b) Convert the given Grammar into GNF: 8 CO3 [K₃]
1. $S \rightarrow XB \mid AA$
2. $A \rightarrow a \mid SA$
3. $B \rightarrow b$
4. $X \rightarrow a$
14. a) Construct a TM for the language $L = \{a^n b^n c^n \mid n \geq 0\}$. 8 CO4 [K₃]
- b) Construct a TM for the subtraction of two unary numbers $f(a-b) = c$ where a is always greater than b. 8 CO4 [K₃]
15. a) If language L and its complement L' are both recursively enumerable then show that L and L' is recursive 8 CO5 [K₂]
- b) Show that the Diagonalization Language L_d is not Recursively Enumerable. 8 CO5 [K₂]
16. a) Check whether the given grammar G is ambiguous or not. 6 CO3 [K₃]
1. $S \rightarrow aSb \mid SS$ 2. $S \rightarrow \epsilon$
- b) Construct a TM machine for checking the palindrome of the string of even length. 10 CO4 [K₃]
