

B.E DEGREE EXAMINATIONS: NOV / DEC 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)**

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|--|-----|-------------------|
| 1. Consider the DFA given. Compute | CO1 | [K ₃] |
| 2. Design an Non-deterministic Finite state Automata without epsilon transitions for the following infinite languages over the alphabet {a,b}.
$L = \{w \mid w\text{'s third symbol from the left end is } b\}$ | CO1 | [K ₃] |
| 3. What are the closure properties of regular languages? | CO2 | [K ₂] |
| 4. Construct epsilon-NFA for the regular expression $(0+1)^*01$. | CO2 | [K ₃] |
| 5. When is PDA said to be deterministic? | CO3 | [K ₂] |
| 6. What is ambiguous grammar? Give example. | CO3 | [K ₂] |
| 7. Define Turing Machine. | CO4 | [K ₂] |
| 8. When is a recursively enumerable language said to be recursive? | CO4 | [K ₂] |
| 9. Identify whether "Tower of Hanoi" problem is tractable or intractable. Justify your answer | CO5 | [K ₃] |
| 10. Prove that the union of two recursive language is recursive. | CO5 | [K ₂] |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

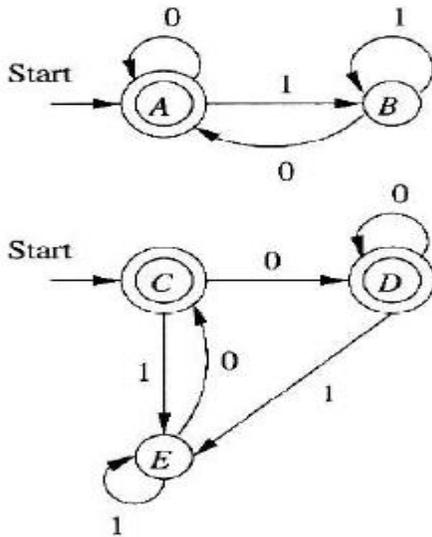
11. a) Consider the following NFA. Convert it into DFA. 8 CO1 [K₃]

δ_N	a	b
$\rightarrow p$	{p,q }	{p}
q	{r,s }	{t}
r	{p,r}	{t}
*s	-	-
*t	-	-

- b) Explain the Chomsky hierarchy of languages. 8 CO2 [K₂]

12. a) Prove that If $D = (Q_D, \Sigma, \delta_D, \{q_0\}, F_D)$ is the DFA constructed from the NFA $N = (Q_N, \Sigma, \delta_N, q_0, F_N)$ by the subset construction, then $L(D) = L(N)$. 8 CO2 [K₂]

- b) Prove that the two automata given accept the same language using Table filling algorithm. 8 CO2 [K₃]



13. a) Prove the following theorem:
 If $L = N(P_N)$ for some PDA $P_N = (Q, \Sigma, \Gamma, \delta_N, q_0, Z_0)$, then there is a PDA P_F such that $L = L(P_F)$ 8 CO3 [K₂]

- b) Construct a PDA for the given context-free language $L : \{a^n b^n \mid n \geq 1\}$, accepting by final state or empty stack. 8 CO3 [K₃]

14. a) Find the Leftmost and Rightmost Derivatives of the string '00110101' for the following grammar 8 CO3 [K₃]
 $S \rightarrow 0B / 1A$
 $A \rightarrow 0 / 0S / 1AA$
 $B \rightarrow 1 / 1S / 0BB$
- b) Consider the grammar with the following productions: 8 CO3 [K₃]
 $S \rightarrow ASB / \epsilon$
 $A \rightarrow aAS / a$
 $B \rightarrow SbS / A / bb$
 (i) Eliminate ϵ - production
 (ii) Eliminate any unit production in the resulting grammar
 (iii) Eliminate any useless symbols in the resulting grammar
 (iv) Derive an equivalent Chomsky Normal Form
15. a) Construct a Turing Machine to check whether a given string of parentheses is balanced. 8 CO4 [K₃]
- b) Prove that following: 8 CO4 [K₂]
 1. Diagonalization language is not recursively enumerable.
 2. The complement of recursive language is recursive
16. a) State and prove Rice's theorem. 8 CO5 [K₂]
- b) For the alphabet set $\{a,b\}$ with $A = \{a,aba^3,ab\}$ and $B = \{a^3,ab,b\}$, Does the PCP with A and B have a solution? 8 CO5 [K₃]
