

# END TERM EXAMINATION

FOURTH SEMESTER [B.TECH] JUNE 2025

Paper Code: CIC-206

Subject: Theory of Computation

Time: 3 Hours

Maximum Marks: 60

Note: Attempt any five questions including Q.No. 1 which is compulsory. Select one question from each unit.

- Q1 Attempt all [4x5=20]
- Describe the Chomsky Classification of language with example.
  - Draw the DFA equivalent to the CFG with productions  $P = \{S \rightarrow 0S/1A, A \rightarrow 1A/0B, B \rightarrow 1B/\Lambda\}$ . Here  $\Lambda$  is used for null.
  - Prove that if there is a polynomial time reduction from  $P_1$  to  $P_2$  and if  $P_2$  is in P then  $P_1$  will be in P.
  - Prove that every language accepted by a multi tape TM is acceptable by some single-tape TM.
  - Define the classes PSPACE and NSPACE complexity classes. Give example problems for both.

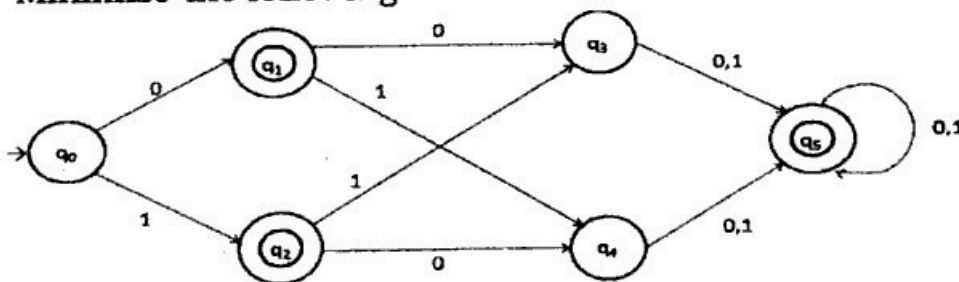
## UNIT-I

- Q2 a) Construct a Mealy machine equivalent to the Moore machine given in the table. [3]

Present State	Next State		Output
	a=0	b=1	
$\rightarrow q_0$	$q_1$	$q_2$	0
$q_1$	$q_3$	$q_2$	1
$q_2$	$q_2$	$q_1$	0
$q_3$	$q_0$	$q_3$	1

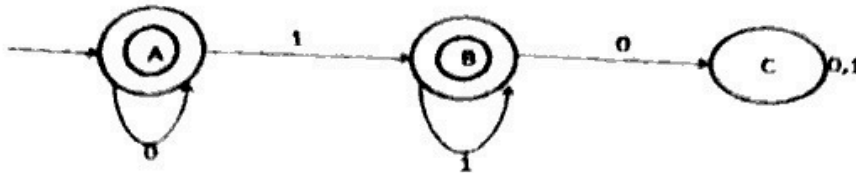
- Construct a DFA to accept all strings over  $\{0,1\}$  which contains three consecutive Zeros. [3]
- Define NFA with the help of an example. [4]

- Q3 a) Minimize the following DFA. [3]

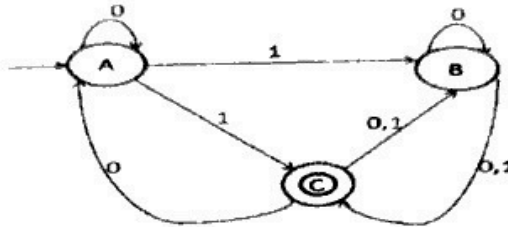


- Find the regular expression for the set  $\{a^n b^m : (n+m) \text{ is odd}\}$ . [1]
  - Find a regular expression over  $\{a,b\}$  for all the strings that start and end with the same symbol. [2]
- Using Pumping Lemma prove that the language  $A = \{a^n b^n \mid n \geq 0\}$  is not regular. [4]

- Q3 a) Write down the regular expression for the following diagram. [4]



- b) Design a FA that accepts all binary strings where 0's and 1's are alternate. [3]  
 c) Convert the following NFA (Figure given below) into an equivalent DFA. [3]



### UNIT-II

- Q4 a) i) What is Context Free Grammar? How it is useful to generate Context Free Language using Push Down Automata? [4]  
 ii) Differentiate between DPDA and NDPDA. [1]  
 b) Explain the language accepted by Pushdown Automata using final state and empty stack with suitable examples. [2.5]  
 c) Draw a pushdown automata for the CFG given below [2.5]  
 $S \rightarrow aSb ; S \rightarrow a/b/\epsilon$

- Q5 a) Define Parsing and Ambiguity. Also explain the Left and Right Derivation tree with the help of an example. [4]  
 b) Convert the following Context Free Grammar to Chomsky Normal Form <https://www.ggsipuonline.com> [3]  
 $P: S \rightarrow ASA/aB, A \rightarrow B/S, B \rightarrow b/\epsilon$   
 c) Explain Closure properties of Context Free Grammar. [3]

### UNIT-III

- Q6 a) Give the Formal definition of Turing Machine. [3]  
 b) Explain the representation of Turing Machine by instantaneous Description using diagram. [3]  
 c) Consider the Turing machine given by the following table and Draw the transition diagram of the Turing machine, where tape symbols are (1,b) and L,R are R/w head moves. [4]

Present State	Input Type	Symbols
	1	b
$\rightarrow q_0$	1 R $q_0$	1 R $q_1$
$q_1$	1 R $q_1$	b L $q_2$
$q_2$	b L $q_3$	—
$q_3$	1 L $q_3$	b R $q_4$
$q_4$	—	—

- Q7 a) Explain Reducibility and undecidability. How can we use Reducibility to prove undecidability? [4]  
 b) Explain Universal Turing Machine. Design a Turing Machine that accepts the language denoted by regular expression  $11^*$ . [3]  
 c) Explain Rices Theorem and Recursion Theorem. [3]

**UNIT- IV**

- Q8 a) In context to Computational Complexity Theory, define [4]  
 i) Solvable and Unsolvble problems  
 ii) Decidable and Undecidable problems.  
 b) Explain P and NP problems. When can we call a problem NP-hard and NP-complete? [3]  
 c) State and prove Cook's Theorem. [3]
- Q9 a) In context to Complexity theory explain PSPACE and NSPACE complexity classes. [4]  
 b) State and Prove Savitch Theorem. [3]  
 c) What do you mean by Interactive proof systems and IP class. [3]

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