Registration No.: | | | | | | | | | | |

Total Number of Pages: 02 **Course: B.Tech**

Sub_Code: RCS5C001/RCS5D007

5th Semester Back Examination: 2025-26

SUBJECT: Formal Languages and Automata Theory

BRANCH(S): CSE, CSEAIML, CSEDS, CSIT, CST, ELECTRICAL & C.E, IT, CSEAI

Time: 3 Hours

Max Marks: 100

Q.Code: U020

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right-hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) Differentiate between NFA and DFA.

b) Explain the purpose of the Myhill–Nerode equivalence relation.

c) List any two algebraic identities of regular expressions.

d) What is an inherently ambiguous grammar? Give an example.

e) What is a Universal Turing Machine?

f) Describe closure under union for regular languages.

g) Distinguish between deterministic and non-deterministic PDAs with examples.

h) What is the Halting Problem? Why is it important?

i) Define leftmost and rightmost derivation in a CFG.

j) Explain Instantaneous Description (ID) for PDA.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) Construct a DFA for all binary strings containing an odd number of occurrences of substring "101"

b) Convert the following NFA to an equivalent DFA:
States: $\{q_0, q_1\}$, Alphabet: {a, b}
Transition: $\delta(q_0, a) = \{q_0, q_1\}$, $\delta(q_0, b) = \{q_0\}$, $\delta(q_1, a) = \{q1\}$, $\delta(q_1, b) = \emptyset$

c) Convert the regular expression (0+1)*011 into a minimal state automaton.

d) Using the Pumping Lemma, show that L = {0^n 1^m 0^n | n,m≥1} is not regular.

e) Simplify the grammar and convert it into CNF: S → AS | aB; A → aA | a; B → bB | b.

f) Analyze why deterministic PDAs cannot recognize all CFLs with examples.

g) Construct a PDA for L = {a^n b^n c^m | m,n≥1} and explain acceptance by empty stack.

h) Explain variants of Turing Machines.

i) State and prove Kleene's Theorem.

j) Derive a regular expression for the FA of a binary counter modulo 3.

k) Prove every deterministic CFL is unambiguous; converse false.

l) Construct a TM to compute f(n) = 2n on unary input.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Create the minimal DFA for L = {w ∈ {0,1}* | w interpreted as binary ≡ 3 (mod 7)}. **(8)**

b) Prove the Myhill–Nerode condition and evaluate minimal DFA generation. **(8)**

Q4 **a)** What is a Mealy Machine? Convert following Mealy Machine to Moore Machine. **(8)**

Present State	Next State			
	Input a = 0		Input a = 1	
	State	Output	State	Output
q_1	q_3	0	q_2	0
q_2	q_1	1	q_4	0
q_3	q_2	1	q_1	1
q_4	q_4	1	q_3	0

b) Design a regular expression for binary strings divisible by 6 and justify correctness. **(8)**

Q5 **a)** Convert S → aSbS | bSaS | ε into CNF and evaluate blow-up. **(8)**

b) Create an unambiguous grammar for L = {a^n b^n c^m | n,m ≥ 1} and justify correctness. **(8)**

Q6 **a)** Explain how a TM computes integer functions. **(8)**

b) Evaluate and prove that MPCP reduces to PCP. **(8)**