Printed Pages:02 **Sub Code:RCS403**

Paper Id: 238260 **Roll No.**

B. TECH
(SEM IV) THEORY EXAMINATION 2022-23
THEORY OF AUTOMATA AND FORMAL LANGUAGES

Time: 3 Hours ***Total Marks: 70***

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

(a) Discuss the concept of formal languages.
(b) Provide proofs for at least three closure properties of regular lnguages.
(c) Explain the Pigeonhole Principle.
(d) Discuss the importance of minimizing automata.
(e) Discuss the concept of ambiguity in context-free grammars.
(f) Define the Greibach Normal Form.
(g) Explain the concept of Nondeterministic Pushdown Automata.

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

(a) Given an NFA without ε-transitions, with the alphabet Σ = {a, b}, and the following transition table:

State	a	b
q0	q1	q0
q1	q2	q1
q2	q2	q0

Determine if the string "aab" is accepted by this NFA. Show the possible state transitions and the final accept/reject decision.

(b) Convert the following Moore machine into an equivalent Mealy machine:

State	Output	0	1
A	1	B	C
B	0	A	C
C	1	B	B

(c) What is the Chomsky Hierarchy? Explain the different levels of the hierarchy and the types of languages associated with each level.

(d) Consider a context-free grammar G with the following productions:
S ->aA
A ->aA | b
Determine whether the language generated by this grammar is regular or not. Justify your answer.

(e) Convert the following nondeterministic pushdown automaton to an equivalent deterministic pushdown automaton:
Q = {q0, q1, q2}, Σ = {0, 1}, Γ = {0, 1, \$}, q0 = q0, F = {q2}, and the transitions are as follows:
δ(q0, ε, ε) = {(q1, \$)}
δ(q1, 0, ε) = {(q1, 0)}
δ(q1, 1, ε) = {(q1, 1)}
δ(q1, ε, 0) = {(q2, ε)}

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) Construct an NFA with ε-transitions that recognizes the language L = {w | w contains at least two consecutive 0s followed by a 1}. Provide the NFA's state diagram and describe its operation.

(b) Consider a DFA with the alphabet Σ = {0, 1} and three states: q0, q1, and q2. The transition table for this DFA is as follows:

State | 0 | 1
q0 | q1| q2
q1 | q1| q2
q2 | q0| q1

Determine if the string "0110110" is accepted by this DFA. Show the state transitions and the final accept/reject decision.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) Prove that the language $L = \{0^n 1^n \mid n \geq 0\}$ is not regular using the Pumping Lemma.

(b) Given two regular languages L1 = (ab)* and L2 = (ba)*, determine whether the intersection of L1 and L2 is a regular language. Justify your answer.

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) Convert the regular grammar given below into a Finite Automaton (FA):
S ->aS | bA
A ->aB | bA
B ->aA | bB
A -> ε

(b) Simplify the following context-free grammar by removing useless symbols and productions:
S -> AB
A ->aB
B -> A | ε
C -> S | ε

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) Prove that the class of context-free languages is closed under the union operation by providing a detailed construction or algorithm.

(b) Given the context-free grammar G:
S ->aSb | ε
A ->aA | ε
B ->bB | ε
C ->cC | ε
Determine whether the string "aaabbbccc" belongs to the language generated by G. If yes, provide a derivation; if no, explain why.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) Consider a Turing Machine that recognizes the language $L = \{ww^R \mid w$ is a string over $\{0, 1\}^*\}$. Design a Turing Machine that accepts this language and provide a detailed explanation of its operation.

(b) Construct a Turing Machine that computes the function $f(n) = n^2$ for any given positive integer n. Provide a formal description of the machine, including its tape alphabet, state transitions, and final output.