


Final Assessment Test - April 2026

Course: BCSE304L - Theory of Computation

Class NBR(s): 3565 / 3588 / 3590

Time: Three Hours

Slot: B1+TB1

Max. Marks: 100

- > KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
 > DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Compare and analyse different computational models.
CO2	Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
CO3	Identify limitations of some computational models and possible methods of proving them.
CO4	Represent the abstract concepts mathematically with notations.

BL - Blooms Taxonomy Level (1 - Remember, 2 - Understand, 3 - Apply, 4 - Analyse, 5 - Evaluate, 6 - Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Consider the languages $L_1 = \{a, ab, ba\}$ and $L_2 = \{b, aa\}$ defined over the alphabet $\Sigma = \{a, b\}$. Construct the languages obtained by performing the following operations:

CO4 BL3

- $L_1 L_2$
- $L_2 L_1$
- L_1^3
- $L_1 \cup L_2$
- $L_1 \cap L_2$

Also, analyze the results obtained and determine which operation produces the maximum number of strings and which operation produces the minimum number of strings. Justify your answer based on the properties of language operations.

2. a) Consider the language L over the alphabet $\Sigma = \{0, 1\}$ such that, [5] CO2 BL3
 $L = \{w = t101 \mid t \in \Sigma^*\}$. That is, the language L consists of all binary strings (w) that end with 101. Construct the Deterministic Finite Automata (DFA) with transition table and identify the accepting state.

b) Construct the Non-deterministic Finite Automata (NFA) over the alphabet $\Sigma = \{a, b\}$ that accepts the language $L = \{w \mid w \text{ contains the substring "abba" or "bab"}\}$. [5]

CO2 BL3

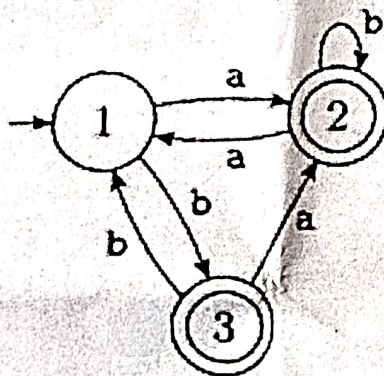
3. An NFA P is given by $(Q, \{0, 1\}, \delta, p_0, F)$ where $Q = \{p_0, p_1, p_2, p_3, p_4, p_5, p_6\}$, $F = \{p_4, p_6\}$ and the transition function δ is given below.

δ	0	1	ϵ
p_0	$\{p_0\}$	$\{p_0, p_1\}$	$\{p_2\}$
p_1	$\{p_3\}$	$\{p_2\}$	-
p_2	$\{p_4\}$	-	-
p_3	-	$\{p_5\}$	$\{p_4\}$
p_4	$\{p_4\}$	-	-
p_5	-	$\{p_6\}$	-
p_6	$\{p_3\}$	-	-

Find a DFA which is equivalent to the NFA P. Also say, whether the DFA is powerful than NFA. Justify your answer.

4. Given a finite automaton, evaluate its transition behaviour and systematically derive a regular expression that generates the same language. Discuss the steps involved and validate the correctness of the expression.

CO2 BL5



5. a) Convert the regular expression $(a + b)^*aba$ into Non-deterministic Finite Automata (NFA). [5]
- b) Prove that the given language $L = \{a^{2n}b^n a^n \mid n \geq 0\}$ is regular or not. [5]

CO2 BL3

6. Given the grammar CO2 BL4
- $$S \rightarrow ABA \mid B \mid \epsilon$$
- $$A \rightarrow 00 \mid \epsilon$$
- $$B \rightarrow 11$$
- a) Analyze the grammar and determine the nullable variables and unit productions. Explain how these productions influence the structure of the generated language.
- b) Transform the grammar into an equivalent grammar in Chomsky Normal Form (CNF) while preserving the language generated by the original grammar.
- c) Further convert the CNF grammar into Greibach Normal Form (GNF).
7. Construct a context-free grammar (CFG) for the language CO3 BL6
- $$L = a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i = j \text{ or } j = k.$$
- Construct the CFG for the language, explain how the grammar handles the two different conditions and provide the leftmost derivation and parse tree for a valid string.
8. Construct the pushdown automata (PDA) which accepts the language CO3 BL6
- $$L = a^{2m} b^n c^n d^{2m} \mid m, n \geq 0.$$
- Give all the specifications of the PDA and the instantaneous description for any one of the strings accepted by the language.
- 9.a) Design of a Turing TM that accepts the language, CO1 BL4
- i. $L = a^n b^{2n} \mid n \geq 1$ [5]
- ii. Analyse different types of Turing Machine (TM). [5]
- OR
- 9.b) Analyze the Turing Machine Halting Problem and discuss, with suitable scenarios, why it cannot be solved by any Turing Machine. CO1 BL4
- 10.a) Construct and explain the Chomsky Hierarchy by describing the different types of languages in order, their corresponding automata and the general form of their grammar rules. Analyse how the increase in computational power affects the types of languages that can be represented with suitable reasoning. CO1 BL4
- OR
- 10.b) Critically analyze the Post Correspondence Problem and illustrate, with suitable examples, how it leads to undecidability in formal language theory. CO1 BL4

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