

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-V (NEW) EXAMINATION – SUMMER 2024****Subject Code: 3151605****Date: 18-05-2024****Subject Name: Formal Language and Automata Theory****Time: 02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

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| Q.1 | (a) State the formal notation for ϵ -NFA. | 03 |
| | (b) Differentiate between a Deterministic Finite Automaton (DFA) and a Nondeterministic Finite Automaton (NFA). | 04 |
| | (c) Construct NFA accepting all string that end in 01 and convert NFA to DFA using the subset construction method. | 07 |
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| Q.2 | (a) Define Regular Expressions. List out Applications of Regular Expressions. | 03 |
| | (b) Explain the concept of equivalence and minimization of Finite Automata. | 04 |
| | (c) Explore the various closure properties of regular languages, including how the union, intersection, and complement of regular languages can be characterized and computed. | 07 |
| OR | | |
| | (c) Describe the Pumping Lemma for regular languages and its role in determining whether a language is regular. Provide an example of how it can be used to prove non-regularity. | 07 |
| | | |
| Q.3 | (a) Write unambiguous grammar of the following grammar.
$E \rightarrow E+E \mid E-E \mid E^* \mid (E) \mid id$ | 03 |
| | (b) Provide a comprehensive overview of context-free grammars, including their formal definition, notation, and use in specifying languages | 04 |
| | (c) Define CFG. Write CFG for the following language.
(i) $L = \{ 0^i 1^j 0^k \mid j > i + k \}$
(ii) $L = \{ 0^i 1^j 0^k \mid i=j \text{ or } j=k \}$ | 07 |
| OR | | |
| Q.3 | (a) Define the terms "generating symbols" and "reachable symbols" in the context of context-free grammars. | 03 |
| | (b) Discuss the differences between Backus-Naur Form (BNF) and Chomsky Normal Form (CNF) in the representation of context-free grammars. | 04 |
| | (c) Consider following grammar:
$S \rightarrow aB \mid bA$
$S \rightarrow aS \mid bAA \mid a$
$B \rightarrow bS \mid aBB \mid b$
Give leftmost and rightmost derivations of string $w = aaabbabbba$.
Also draw the parse tree corresponding to this string. | 07 |

- Q.4** (a) Describe Chomsky Hierarchy in brief . **03**
 (b) Define the term "deterministic Pushdown Automaton" (DPDA) and discuss the differences between DPDAs and non-deterministic PDAs (NPDAs). **04**
 (c) Define Push Down Automata. List out the operations performed on Push Down Automata (PDA). Construct the PDA over alphabet $\Sigma = \{0,1\}$ for the Language $L = \{0^n 1^n \mid n \geq 0\}$. Justify your answer. **07**
- OR**
- Q.4** (a) Explain the intersection and complement operations on Context-Free Languages (CFLs) and why these operations are valuable for language manipulation. **03**
 (b) Discuss the equivalence between Pushdown Automata (PDAs) and Context-Free Grammars (CFGs). **04**
 (c) Construct PDA for $L = \{a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i=j \text{ or } i=k\}$ **07**
- Q.5** (a) Define Post's Correspondence Problem and provide its formal formulation. **03**
 (b) Explain the concept of primitive recursive functions and their role in computability theory. Provide a basic example **04**
 (c) Construct a Turing Machine to accept palindromes over $\{a,b\}^*$. **07**
- OR**
- Q.5** (a) Provide an overview of the Turing Machine and its fundamental components, such as the tape, head, states, and transition functions. **03**
 (b) Define partial functions and total functions in the context of computable functions. **04**
 (c) Construct a Turing machine accepting $\{xx \mid x \in \{a, b\}^*\}$. **07**
