

Roll No.

Total Pages : 03

BT-5/D-24

45170

**FORMAL LANGUAGE AND
AUTOMATA THEORY
PC-CS-303 A**

Time : Three Hours]

[Maximum Marks : 75

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. All questions carry equal marks.

Unit I

1. (a) Create a regular expression to identify valid variable names in a programming language. A variable name should : begin with a letter (a-z or A-Z) or an underscore (`_`) and be followed by letters, digits (0-9), or underscores.
- (b) Prove that every ϵ -NFA can be converted to an equivalent NFA without ϵ -transitions. Describe the steps involved in this conversion.
2. (a) What are the fundamental differences between a Deterministic Finite Automaton (DFA) and a Non-deterministic Finite Automaton (NFA) ? Prove that

every language that can be accepted by an NFA can also be accepted by a DFA.

- (b) Define Finite State Automata. Construct a DFA for the regular expression $(0 | 1)^*00(0 | 1)^*$.

Unit II

3. (a) Use the Pumping Lemma to prove that the language $L = \{a^n b^n c^n \mid n \geq 1\}$ is not context-free.
- (b) Why is every Type 2 language also a Type 1 language, but the reverse is not true? Provide an example to illustrate this point.
4. (a) Define the concept of ambiguity in context-free languages. Can every ambiguous context-free language be converted into an unambiguous grammar? Discuss.
- (b) Construct a context-free grammar for the language $L = \{a^n b^m \mid n, m \geq 1 \text{ and } n \leq m\}$. Show that this language is context-free.

Unit III

5. (a) What is a Moore machine? Construct a Moore machine that outputs 1 whenever it encounters three consecutive 1s in the input sequence and outputs 0 otherwise.

- (b) Define a Push-down Automaton (PDA). What are the components of a PDA ? Provide the formal definition of a PDA using the tuple notation.
6. (a) What is Mealy machines ? Explain why Mealy machines tend to have fewer states than Moore machines for the same problem.
- (b) What is the relationship between Context-Free Grammars (CFGs) and PDAs ? How can a CFG be converted to an equivalent PDA ?

Unit IV

7. (a) Define Post's Correspondence Problem (PCP). Prove that the Post's Correspondence Problem is undecidable.
- (b) Describe the relationship between the classes P and NP. Is P a subset of NP ? Explain.
8. (a) State Rice's Theorem. Explain why the property "the language recognized by a Turing machine is finite" is undecidable according to Rice's Theorem.
- (b) What is the Travelling Salesman Problem (TSP) ? Is it NP-complete ? Justify your answer.