2025

COMPUTER SCIENCE — HONOURS

Paper : CC-14

(Introduction to Theory of Computation)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.*** **1** and ***any four*** from the rest.

1. Answer ***any five*** questions : 2×5

(a) State the mathematical definition of a finite automaton.

(b) When are two states q_1 and q_2 of an automaton said to be equivalent?

(c) Construct a DFA accepting all strings w over $\{0, 1\}$ such that the number of 1's in w is 2 mod 3.

(d) When can we say that a string x is accepted by a finite automaton?

(e) Why is it necessary to minimize the number of states in a finite state machine?

(f) When is a grammar said to be a type-3 or regular grammar? State the form of production in defining such type of grammar.

(g) Draw a model of a single tape Turing machine defining all its components.

(h) Define null production and unit production.

2. (a) Define Moore machine. How is it different from a Mealy machine?

(b) Construct a Moore machine by transforming the following Mealy machine.

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

(2+2)+6

Please Turn Over

3. (a) Briefly state the steps to convert a DFA to a minimal DFA.

   (b) Construct a finite NDFA accepting {ab, ba} and use it to find a DFA accepting the same set. 4+6

4. (a) Define a grammar by giving its formal structure.

   (b) Consider the grammar G given below. Find the language generated by it. Show the steps clearly.

   $S \rightarrow 0\,S\,I \mid 0\,A\,I, \quad A \rightarrow I\,A \mid I$ 4+6

5. (a) How many types of grammars did Chomsky classify? Illustrate by means of a block diagram the languages formed by the grammar.

   (b) Construct a grammar G accepting the set L of all strings over {0, 1} having more 1's than 0's. (1+2)+7

6. (a) Give the formal definition of regular expressions over Σ.

   (b) Describe the following sets by regular expressions.

   (i) L_1 = the set of all strings of 0's and 1's begining with 0 and ending with 1.

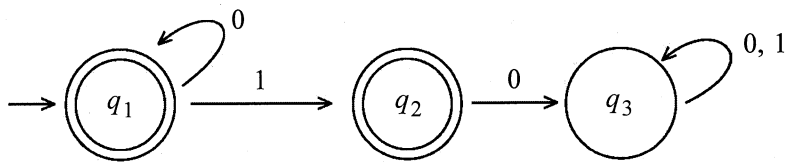
   (ii) $L_2 = \{ \epsilon, 11, 1111, 111111, \ldots\ldots \}$

   (c) Prove that $(a + b)^* = a^* (ba^*)^*$, where $\Sigma = \{ a, b \}$. 3+(2+2)+3

7. (a) Define a push down automata.

   (b) When is a grammar said to be an ambiguous grammar? Give an example.

   (c) For the following transition table, use Arden's theorem to find out the regular expression for the strings represented by it.



2+(2+2)+4

8. (a) Give the formal definition of a Turing machine.

   (b) What is the significance of the halting problem in Turing machine?

   (c) Design a Turing machine to recognize all strings consisting of even number of 1's. 4+2+4
