2023

COMPUTER SCIENCE — HONOURS

Paper : CC-14

(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*** questions from the rest.

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

(a) Explain briefly why it is necessary to find a minimum automaton.

(b) Find the highest type number which can be applied to the following grammar.

$S \to aA,\ A \to aAa,\ A \to a$

(c) Give the regular expression for the strings with an odd number of a's and even number of b's.

(d) Draw a state diagram of DFA which recognizes the string 1010.

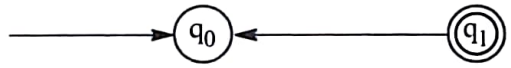
(e) State an application of push-down automaton.

(f) State the purpose of null production in a context-free grammar.

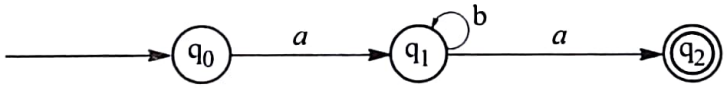
(g) Let $\Sigma = \{a, b\}$. Let L be a language, where no two a's or no two b's come together. Write down the regular expression representing such a language.

(h) Write down the regular expressions of the following transition systems.

(i)



(ii)



2. (a) Define finite automata.

(b) Let $M = (Q, \Sigma, \delta, q_0, F)$ be a finite automaton. Let R be a relation in Q defined by $q_1\ R\ q_2$ if $\delta(q_1, a) = \delta(q_2, a)$ for all $a \in \Sigma$. Is R an equivalence relation?

(c) Consider the language $L = \{a^n b^n;\ n \geq 0\}$. Find a context-free grammar G which generates L. Find a regular grammar G which generates L. 2+4+4

3. (a) Differentiate between non-deterministic finite automaton and deterministic finite automaton.

(b) Construct a non-deterministic finite automaton accepting the set of all strings over $\{a, b\}$ ending in baa. Use it to construct a DFA accepting the same set of strings. 2+3+5

4. (a) Discuss about Chomsky's classification of grammar.

(b) Find the language generated by the following grammar :

$S \rightarrow 0S1 \mid 0A1,\ A \rightarrow 1A \mid 1.$ 4+6

5. (a) Construct a grammar accepting the following set :

$\{0^n 1^{2n} \mid n \geq 1\}$

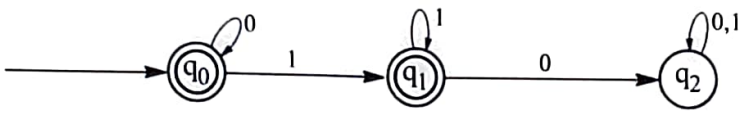
(b) Prove the following identity :

$(a^* ab + ba)^* a^* = (a + ab + ba)^*$ 5+5

6. (a) Represent the following set by regular expression.

$\{a^n \mid n$ is divisible by 2 or 3 or $n = 5\}$

(b) State Arden's theorem. Find the regular expression for the following deterministic finite automata using Arden's theorem.



4+(2+4)

7. (a) Define Turing machine.

(b) What do you understand by Instantaneous Description?

(c) Design a Turing machine that converts a binary string into its equivalent unary string. 2+2+6

8. (a) Write down the steps to convert a deterministic finite automata to minimal deterministic finite automata.

(b) Construct a Turing machine to recognize the language $\{a^n\ b^n\ c^m \mid n, m \geq 1\}$. 4+6