2022

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) When is a string y said to be accepted by a finite automaton M?

(b) Prove that if δ is a transition function such that $\delta(q, w) = \delta(q, x)$, then $\delta(q, wy) = \delta(q, xy)$.

(c) Draw a transition diagram for a DFA M that accepts the string 101101 over $\Sigma = \{0, 1\}$.

(d) Define Push-down Automata.

(e) Give a context-free grammar of palindrome.

(f) What is Context Sensitive Grammar?

(g) Draw the transition diagram of a FA which accepts the strings having any number of a's (possibly ϵ) followed by any number of b's (possibly ϵ) in $\Sigma = \{a, b\}$. Write the regular expression also.

(h) State one similarity and one dissimilarity between a Turing machine and a General purpose computer.

2. (a) Convert the following Mealy machine M to an equivalent Moore machine. Show the steps clearly.

Present State	Next State			
	$a = 0$		$a = 1$	
	State	Output	State	Output
$\rightarrow q_1$	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

(b) Find the language generated by the following grammar : $S \rightarrow 0A|1S|0|1,\ A \rightarrow 1A|1S|1$ 5+5

Please Turn Over

3. (a) Why is a NDFA called so? Draw the transition diagram of a NDFA that accepts all strings whose second last symbol is b where $\Sigma = \{a, b\}$.

(b) Construct a DFA from the NDFA constructed in the previous part [i.e. 3(a)]. (1+4)+5

4. (a) Construct a grammar that accepts the following set.

$$\{0^n 1^m 0^n \mid m, n \geq 1\}$$

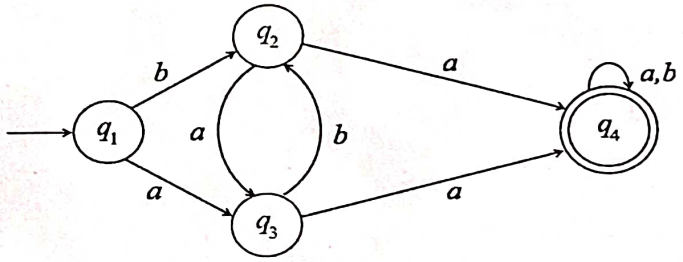
(b) Write down the steps to convert a non-deterministic finite automata into equivalent deterministic finite automata. 5+5

5. (a) Find the language generated by the grammar $S \rightarrow AB$, $A \rightarrow A1|0$, $B \rightarrow 2B|3$. Can the above language be generated by a grammar of higher type?

(b) Design a Turing machine over $\{1, b\}$ which can compute concatenation function over $\Sigma = \{1\}$. If a pair of words (w_1, w_2) is the input, the output has to be $w_1 w_2$. 5+5

6. (a) Write the regular expressions (over $\Sigma = \{a, b\}$), for the case when no two a's or no two b's appear together.

(b) Use Arden's method to find the regular expression from the following DFA. Show the steps. 5+5



7. (a) Prove the following identity :

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

(b) In a context free grammar what is a null production? Give an example.

(c) When is a variable A in a context free grammar said to be nullable? 6+(2+1)+1

8. (a) Let $G = (\{A, B, S\}, \{0, 1\}, P, S\}$, where P consists of $S \rightarrow 0AB$, $A0 \rightarrow S0B$, $A1 \rightarrow SB1$, $B \rightarrow SA$, $B \rightarrow 01$. Find the language generated.

(b) State the significance of the Halting problem in Turing machine.

(c) Design a Turing machine to recognize all strings containing even number of 1's. 5+2+3