Code : 051511

B.Tech 5th Semester Exam., 2019

FORMAL LANGUAGES AND AUTOMATA THEORY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

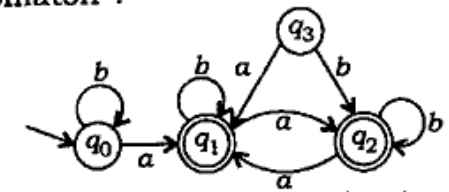
*(ii) There are **EIGHT** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer for any *seven* of the following : 2×7=14

(a) Consider the following finite state automaton :



The language accepted by this automaton is given by the regular expression

(i) $b^*ab^*ab^*ab$

(ii) $(a+b)^*$

(iii) $b^*a(a+b)^*$

(iv) b^*ab^*ab

(b) Definition of a language L with alphabet $\{a\}$ is given as

$L = \{a^{nk} | k > 0,$ and n is a positive integer constant$\}$

What is the minimum number of states needed in a DFA to recognize L?

(i) $k+1$

(ii) $n+1$

(iii) $2^{(n+1)}$

(iv) $2^{(k+1)}$

(c) A minimum state deterministic finite automation accepting the language $L = \{W | W \in \{0, 1\}^*$, number of 0's and 1's in W are divisible by 3 and 5 respectively has

(i) 15 states

(ii) 11 states

(iii) 10 states

(iv) 9 states

(d) Consider the following languages :

GATE[2005] $L_1 = \{uwRw \in \{0, 1\}^* 1\}$,

$L_2 = \{w\#uw \in \{0, 1\}^*\}$,

where # is a special symbol,

$L_3 = \{uuw \in \{0, 1\}^*\}$

Which one of the following is true?

(i) L_1 is a deterministic CFL

(ii) L_2 is a deterministic CFL

(iii) L_3 is a CFL, but not a deterministic CFL

(iv) L_3 is a deterministic CFL

(e) Consider the following statements about the context-free grammar :

(1) $G = \{S \rightarrow SS, S \rightarrow ab, S \rightarrow ba, S \rightarrow \varepsilon\}$

(2) G is ambiguous

(3) G produces all strings with equal number of a's and b's

G can be accepted by a deterministic PDA. Which combination below expresses all the true statements about G?

(i) 1 only

(ii) 1 and 3

(iii) 2 and 3

(iv) 1, 2 and 3

(f) Consider the grammar G whose SLR parser has n_1 states and LALR parser has n_2 states. What is the relation between n_1 and n_2?

(i) $n_1 = n_2$

(ii) $n_1 < n_2$

(iii) $n_1 > n_2$

(iv) None of the above

(g) Let w be any string of length n in $\{0, 1\}^*$. Let L be the set of all substrings of w. What is the minimum number of states in a non-deterministic FA that accepts L?

(i) $n - 1$

(ii) n

(iii) $n + 1$

(iv) $2n - 1$

(h) Consider the regular expression $(0 + 1)(0 + 1) \ldots N$ times. The minimum state FA that recognizes the language represented by this regular expression contains

(i) n states

(ii) $(n + 1)$ states

(iii) $(n + 2)$ states

(iv) None of the above

(i) In Mealy machine, output is a function of

(i) present state only

(ii) next state only

(iii) present state and input

(iv) input only

10 (j) Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following is necessarily true?

(i) $m <= 2n$

(ii) $n <= m$

(iii) M has one accept state

(iv) $m = 2n$

2. (a) Design deterministic finite automata for the set of strings over the alphabet $\{a, b\}$ containing at least three occurrences of three consecutive b's, overlapping permitted (e.g., the string $bbbbb$ should be accepted).

(b) Let $\Sigma = \{0, 1\}$. Let L be the language that consists of strings having either 01 repeated one or more times or 010 repeated one or more times. Is L regular? Explain. 7+7=14

3. (a) Assume that a regular language L is provided to you as a DFA M $\{Q, \Sigma, \delta, q_0, F\}$. How would you check whether L is infinite?

(b) Design a push-down automata for accepting the string for the language $L = \{WW^R \mid W \in (a, b)^*\}$ by the empty stack as well as final state. 7+7=14

4. (a) Construct a Moore machine which determines the residue mod 3 for each binary string treated as binary integer. And then convert into the corresponding Mealy machine.

(b) Design finite state machine or abstract model for binary adder. 7+7=14

5. (a) Prove that the language $L = \{a^{i^2} \mid i \geq 1\}$ is not context-free language.

(b) Show that L = palindrome over $\{a, b\}$ is not regular. 7+7=14

6. (a) Consider the following language :

$L = \{a^m b^{2n} c^{3n} d^p : p > m \text{ and } m, n \geq 1\}$

Write a context-free grammar to generate L and write shortest string in L.

(b) Convert the following context-free grammar into GNF :

$S \rightarrow XY$

$X \rightarrow YS \mid b$

$Y \rightarrow SX \mid a$

7+7=14

7. (a) Construct a push-down automata that accepts the following language :

$L = \{uawb : u \text{ and } w \in (a, b)^* \text{ and } |u| = |w|\}$

(b) Using the following grammar

$S \rightarrow AB \mid BC$

$A \rightarrow BA \mid a$

$B \rightarrow CC \mid b$

$C \rightarrow AB \mid a$

use the CYK algorithm to determine whether the given string *baaba* is in $L(G)$ or not. 7+7=14

8. (a) Design a Turing machine to perform 2's compliment operation on binary string.

(b) Write short notes on the following :

(i) Deterministic PDA vs. non-deterministic PDA

(ii) Universal Turing machine

(iii) Non-deterministic Turing machine

(iv) Post correspondence problem (PCP)

7+7=14

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