Bihar Engineering University, Patna

B.Tech 5th Semester Examination, 2024

Course: B.Tech | ***Time: 03 Hours***

Code: 105503 | ***Subject: Formal Language & Automata Theory*** | ***Full Marks: 70***

Instructions:-

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

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

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

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

Q.1 Choose the correct option / answer the following (Any seven question only): **[2 x 7 = 14]**

(a) In Chomsky hierarchy, which type of grammar corresponds to Regular languages?
(i) Type-0
(ii) Type-1
(iii) Type-2
(iv) Type-3

(b) Which language is generated by the grammar $S \rightarrow aS \mid bS \mid \varepsilon$?
(i) All strings over {a, b} ending with a
(ii) All strings over {a, b}
(iii) All strings over {a, b} starting with b
(iv) Only ε

(c) The pumping lemma is used to
(i) Prove that a language is regular
(ii) Construct regular expressions
(iii) Minimize DFA
(iv) Prove a language is not regular

(d) Which of the following regular expressions represents the language of all strings containing an even number of a's?
(i) (aa)*
(ii) a*
(iii) (a|b)*
(iv) a^+b^+

(e) Which form is used to convert CFGs into a format suitable for parsing algorithms?
(i) Chomsky Normal Form
(ii) Greibach Normal Form
(iii) Both a and b
(iv) Pumping Form

(f) Ambiguity in CFG means
(i) CFG generates no string
(ii) CFG has more than one leftmost derivation for the same string
(iii) CFG produces infinite strings
(iv) Grammar has no terminal symbols

(g) Which of the following is true for context-sensitive languages (CSL)?
(i) Closed under union
(ii) Closed under complement
(iii) Accepted by linear bounded automata
(iv) All of the above

(h) Which of the following is undecidable?
(i) Whether a DFA accepts a string
(ii) Whether a Turing machine halts on all inputs
(iii) Whether a CFG generates a particular string
(iv) Whether two DFAs accept the same language

(i) A language is said to be recursively enumerable if
(i) There exists a TM that halts on every input
(ii) There exists a TM that accepts all strings and rejects all non-members
(iii) There exists a TM that accepts strings in the language and may loop on non-members
(iv) It can be expressed by regular expressions

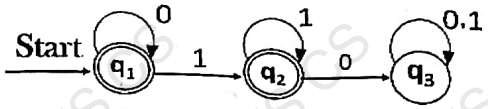
(j) Which of the following language classes is accepted by a Turing machine that always halts?

(i) Regular
(ii) Context-Free
(iii) Recursive
(iv) Recursively Enumerable

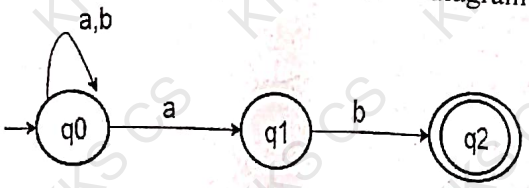
Q.2 (a) Define finite Automata. Also, write down the differences among DFA, NFA and ε-NFA. [7]

(b) Define pumping lemma for regular language. Show that L= $\{a^n b^n \mid n>=0\}$ is not regular using pumping lemma. [7]

Q.3 (a) Define Arden's Theorem. Find regular expression for the following DFA using Arden's Theorem [7]



(b) Construct the DFA from the following NFA transition diagram [7]



Q.4 (a) Define closure properties of regular language. Why we use closure properties of regular languages. What is reversal of a language? [7]

(b) Explain the different types of grammar according to Noam Chomsky. [7]

Q.5 (a) Construct the deterministic PDA to accept the language L= $\{a^n c b^n \mid n>=1\}$ by an e mpty state. [7]

(b) Describe the normal forms. Construct a CNF form the following CFG: [7]

$S \rightarrow AB$
$A \rightarrow aAa \mid a$
$B \rightarrow Bb \mid b$

Q.6 (a) Construct the Turing machine for the language L= $\{a^n b^n \mid n>=1\}$ and the transition table. [7]

(b) Define derivation tree. Construct a derivation tree for the string "aabbabba" for the CFG given by, [7]

$S \rightarrow aB \mid bA$
$A \rightarrow a \mid aS \mid bAA$
$B \rightarrow b \mid bS \mid aBB$

Q.7 (a) Define the Turing machine. Explain the general structure, and working of single tape of the Turing machine with diagram. [7]

(b) Define context-sensitive grammar with an example. How does it differ from context-free grammar? [7]

Q.8 (a) Prove that the language L = $\{a^n b^n c^n \mid n \geq 1\}$ is context-sensitive but not context-free. [7]

(b) Explain the Church-Turing thesis. Why is it important in the theory of computation? [7]

Q.9 (a) What is the diagonalization language? Show that it is not recursively enumerable. [7]

(b) Define an Alphabet, String, Language and Grammar with suitable examples. [7]