

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO/SP20**)**

CLASS: BTECH / IMSC
BRANCH: CSE/IT/IMH

SEMESTER : V
SESSION : MO//2022

SUBJECT: CS310 FORMAL LANGUAGES AND AUTOMATA THEORY

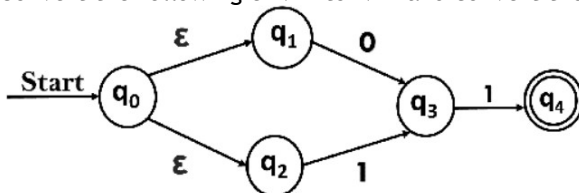
TIME: 03 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

- Q.1(a) What is an expressive power of automata? Compare different automata in term of expressive power. [2]
Q.1(b) Convert the following e-NFA to NFA and convert the resultant NFA to DFA [3]



- Q.1(c) Construct the minimal DFA that accept all strings contain even numbers of a's, b's and c's over $\Sigma = \{a, b, c\}$ [5]
- Q.2(a) State Arden's Theorem [2]
Q.2(b) State and explain Pumping Lemma with suitable example [3]
Q.2(c) Write regular expression for strings contain substring "00" over $\Sigma = \{0, 1\}$ and convert it into corresponding DFA. [5]
- Q.3(a) Define Grammar in the context of formal language. Differentiate recursive and non-recursive grammar with a suitable example. [2]
Q.3(b) Construct a CFG to generate even and odd length palindrome over the alphabet $\{a, b\}$. [3]
Generate CFG for the language $L = \{a^m b^n \mid m > n\}$
Q.3(c) Write down the steps to transform a grammar into Chomsky Normal form and Greibach Normal Form (GNF) [5]
Find the equivalent grammar in the form of CNF and GNF
 $S \rightarrow bA \mid aB$
 $A \rightarrow bAA \mid aS \mid a$
 $B \rightarrow aBB \mid bS \mid b$
- Q.4(a) Define push down automata. Differentiate non-deterministic and deterministic push down automata with example. [2]
Q.4(b) Define ambiguous grammar with suitable example. How it differs from unambiguous grammar? [3]
Q.4(c) Construct the PDA for the following languages [5]
 1. $L = \{a^n b^n \mid n > 1\}$
 2. $L = \{a^n b^m a^m b^n \mid m, n > 0\}$
- Q.5(a) Explain the Post correspondence problem? Find the solution of PCP for following set of strings. [2]
 $X = \{bbab, ab, baa, a\}$
 $Y = \{a, abbb, aa, bb\}$
- Q.5(b) Construct a Turing machine to add two unary numbers. Numbers will separated by a single blank space. The head of the machine is made to point to a symbol of second number initially. [3]
Q.5(c) Write short notes on the following [5]
 - Halting Problem in Turing machine
 - P, NP, NP-Complete and NP-hard Problem