Registration No: | | | | | | | | | | |

Total Number of Pages: 03

Course: BTECH
Sub_Code: RCS5C001

5th Semester Regular/Back Examination: 2023-24
SUBJECT: Formal Languages and Automata Theory
BRANCH(S): CSE/CSEAIME/CSIT/CST/Electrical&C.E, Electronics&C.E/IT
Time: 3 Hour
Max Marks: 100
Q.Code: N330

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) Construct a Deterministic Finite Automata (DFA) for L = {set of all strings where the number of 'a' and the number of 'b' in the string is even} over ∑ = {a, b} }.

b) Classify different types of Turing Machine.

c) Write regular expression that represents the language of all strings over {0,1} which ends with either 0 or 11.

d) Consider the grammar G, where the productions are

$E \rightarrow F - E \mid E - F \mid F$

$F \rightarrow a \mid b$

Prove that the Grammar is ambiguous for the string **a – b**.

e) Construct the grammar to derive the language L = {wcw^r |w ϵ {a,b}* and w^r is reverse of string w.}

f) Differentiate between Chomsky Normal Form (CNF) and Greibach Normal Form (GNF).

g) State the halting problem of Turing machine.

h) Can a context-free grammar generate an infinite language? Justify your answer.

i) Define K-Clique problem. State whether the problem belongs to Class P or Class NP.

j) Differentiate between recursive and recursively enumerable language.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 × 8)**

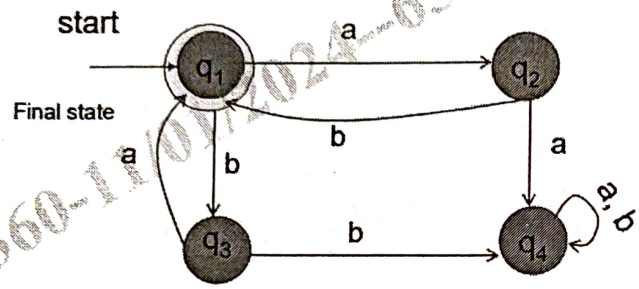
a) Construct a DFA for L = {set of all strings where the number of 'a' in the string is at least 2} over ∑ = {a, b}}. NFA is more powerful than DFA. State true or false. Justify your answer.

b) Construct ϵ - NFA for the regular expression R = (cd | c)*. Construct the equivalent DFA by ϵ-closure method for the given regular expression.

c) Construct a minimum state automaton equivalent to given automaton whose transition table is given below:

States/Input	a	b
→q0	q1	q3
q1	q2	q4
q2	q1	q4
q3	q2	q4
*q4	q4	q4

d) State Arden's Lemma and find the regular expression corresponding to the automaton given below:



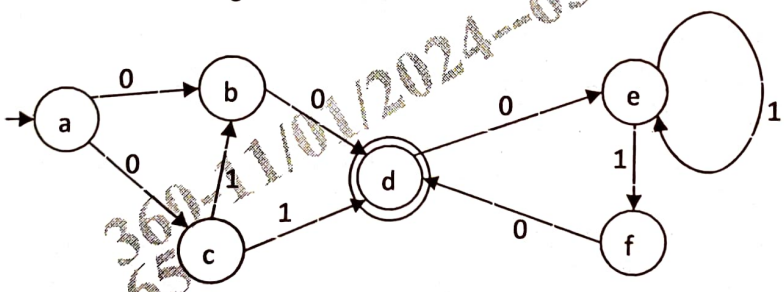
e) Use pumping lemma to prove that the language L= {a^p|p is a prime} is not regular.

f) Compare Deterministic and Non deterministic PDA. Is it true that non deterministic PDA is more powerful than that of deterministic PDA? Justify your answer.

g) List the main application of pumping Lemma in CFL's

h) Compare and contrast the Moore machine and Mealy machine models of finite state machines. Provide five distinct points of comparison.

i) Convert the following NFA to DFA.



j) Define Ackermann's function. Using the function, find out the values of A (2, 1) and A (2, 2).

k) Show that the following functions are primitive recursive.

I. f (x,y) = x*y

II. f (x,y) = x^y

l) Differentiate between P and NP class of problems.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Explain the Chomsky hierarchy of languages, including the four types of languages and their associated grammars. **(8)**

b) List out the identities of Regular Expressions. Apply the identities of regular expressions to prove the following: (1+00*1)+(1+00*1)(0+10*1)*(0+10*1) = 0*1(0+10*1)*. **(8)**

Q4 **a)** Design a Push Down Automata (PDA) accepting the language **$L= \{0^n1^m0^m1^n \mid m, n \geq 1\}$.** **(8)**

b) Convert the following Language to Chomsky Normal Form (CNF), **(8)**

S → abSb | aAb | a
A → bS | aAAb

Q5 **a)** Discuss variants of Turing Machine. Design a Turing Machine that will accept the language **$L = \{0^n1^n \mid n \geq 1\}$.** **(8)**

b) Differentiate between recursive language and recursive enumerable language. Prove that recursive languages are closed under Union, Complement. **(8)**

Q6 **a)** Show the relationship between NP-Complete and NP-Hard problems. Prove that Class P problems are closed under Union, Complement. **(8)**

b) Explain the meaning of polynomial time reduction. Prove that if B is in P and $A \leq_P B$, then A is in P. **(8)**