Nirma University

Institute of Technology

Semester End Examination (IR), December - 2019

B. Tech. in Computer Engineering / Information Technology, Semester-V

CE501 Theory of Computation

Roll / Exam No. _____ Supervisor's Initial With Date _____

Time: 3 Hours Total Marks: 100

Instructions: 1. Figures to the right indicate marks.
2. Draw neat sketches wherever necessary
3. Assume abbreviations: (1) DFA- Deterministic finite automaton
(2) NFA- Non Deterministic finite automaton
(3) PDA-Push down Automata

Section – I

Q:1 **Answer the following question. (4 X 4)** **[16]**

A co1,L2 Prove using mathematical induction that for every positive integer n,

$$\sum_{i=1}^{n} i * 2^i = (n-1) * 2^{n+1} + 2$$

B co1,L2 Write recursive definitions for the following languages.
(a) The set L, as length function to calculate length of the string
(b) The set A of all the strings of the form $a^i b^j$ such that i>=2j

C co2,L3 Let L be the language mentioned as: the set of strings over alphabet {0, 1, 2} that do not have two consecutive identical symbols. (Explanation: strings of L are any string in {0, 1, 2}* such that there is no occurrence of 00, no occurrence of 11, and no occurrence of 22.) Design DFA for the above language.

D co1,L2 (a) What is the relationship between $2^{A \cup B}$ and $2^A \cup 2^B$?
(b) What is the relationship between $2^{(A')}$ and $(2^A)'$?

Q:2 **Answer the following Questions.** **[16]**

A co2,L2 Write down Regular Expression for following Languages [04]
1. The language of all strings with atleast two 1's and atmost two 0's.
2. The language of all strings that do not contain the substring 110.

B co3,L3 Design an NFA for the language L = {w | w is a C programming comment}, consider $\Sigma = \{*, a, /\}$, where 'a' is the valid C statement. [06]

OR

B co3,L4 Design a DFA over binary input such that when the binary input is converted into the corresponding decimal value, then the number is divisible by 7. The DFA should not accept the leading 0's in the input. [06]

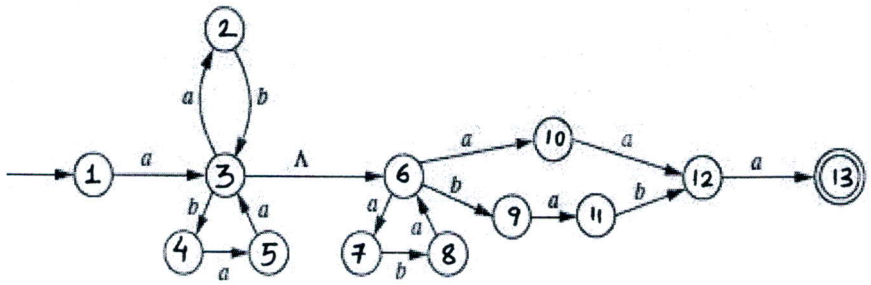
C co3,L4 Design DFA accepting the language L_2-L_1 in {0,1}* for the following language. [06]

L1= { Strings containing the substring 11 }

L2= { Strings do not end with 11}

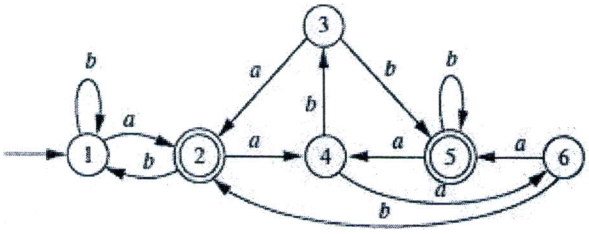
Q:3 Answer the following Questions. **[18]**

A co4,L2 Convert Following NFA-∧ to DFA. [06]



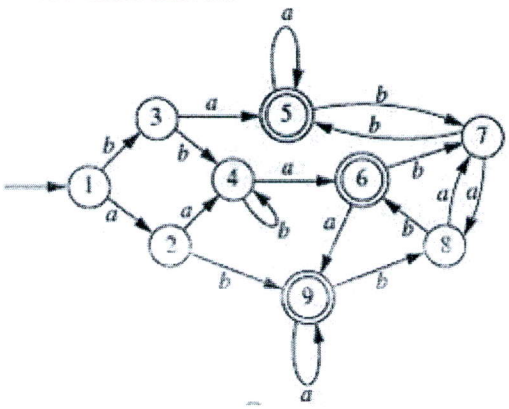
B co1,L2 Describe the importance of pumping lemma. Show that the language $L=\{0^p \mid P \text{ is the prime number}\}$ is not regular language using pumping lemma. [06]

C co4,L4 Minimize following Finite automata. [06]



OR

C co4,L4 Minimize following Finite automata. [06]



Section - II

Q:4 Answer the following question. Justify your answer. (4 X 4) **[16]**

(1) co2,L2 Find out CFG for the language L, where L(G)= {w#w^r x| w^r is reverse string of w and x ∈ { a ,b }*

(2) co2,L2 Describe the language for which following CFG is designed.
a. S -> aSa | bSb | a | b
b. S -> SS | bTT | TbT |TTb | null and T -> aS |SaS |Sa |a

(3) co2,L3 Find the language accepted by the following grammar:
$S \rightarrow 0X \mid 1Y \mid \wedge$
$X \rightarrow 0S \mid 1Z$
$Y \rightarrow 1S \mid 0Z$
$Z \rightarrow 0Y \mid 1X$

(4) co2,L2 Find out CFG for the language L, where $L(G)= \{(ab)^n (cb^m)^n \mid n>0, m>0\}$

Q:5 **Answer the following Questions.** **[18]**

A Do as directed. [12]

1 co3,L3 Is it possible to design a deterministic PDA (DPDA) for the language $L= \{ww^r\}$ where $w \in \{a,b\}^*$? Give reason for our answer. If it is not accepted by DPDA then design the corresponding non deterministic PDA which accepts the given language. [06]

OR

1 co3,L3 Design a PDA to accept the language L where $L \in \{a,b,c\}^*$ and $L = \{a^i b^j c^k \mid i=j \text{ or } i=k\}$. Trace the designed PDA to accept the string "aaabccc". [06]

2 co3,L3 Design a PDA to recognize the set of all strings over {0,1} that ends with 101. [06]

B co4,L3 Convert following CFG to CNF [06]
$S \rightarrow ABC \mid BaB$
$A \rightarrow aA \mid BaC \mid aaa \mid BD$
$B \rightarrow bBb \mid a \mid D$
$C \rightarrow CA \mid AC$
$D \rightarrow \wedge$

Q:6 **Answer the following Questions.** **[16]**

A co4,L3 Draw a Turing machine for the language L to compute n mod 3.(unary number as input) [06]
$f(x)=\begin{cases} 1 \text{ if } x \in L \\ 0, \text{otherwise} \end{cases}$

B co4,L3 Draw a Turing machine for function f from N to N, $f(X) = X+X^2$. (unary number as input) [06]

OR

B co3,L3 Draw a Turing machine to delete the occurrence of special character '@' from the string of binary input. If the input is 0100@11 then the machine should delete the '@' and give 010011 as output. [06]

C co2,L4 Check whether following grammar is ambiguous or not. Find out an equivalent unambiguous grammar. [04]
$S \rightarrow a \mid aAb \mid abSb$
$A \rightarrow aAAb \mid bS$