Nirma University

Institute of Technology

Semester End Examination (IR), December - 2016

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

CE501 Theory of Computation

RollNo/ Exam No | Supervisor's Initial with date

Time: 3 Hours | Max Marks: 100

Instructions: 1. Attempt all questions. Figures to right indicate full marks.
2. Use section wise separate answer book.
3. Assume additional information if required.

SECTION-I

Q-1 Answer the following questions: **[18]**

a) Define following terms: **[6]**
i. Finite State Automata
ii. Regular Expression
iii. Distinguishable Strings
iv. ^-closure
v. δ^* for NFA-^
vi. Pumping lemma for regular languages

b) In each case, a relation on the set {1,2,3} is given. Of the three properties, reflexivity, symmetry and transitivity determine which ones the relation has, give reasons. **[4]**
1. R={(1,3),(3,1),(2,2)}
2. R={(1,1),(2,2),(3,3),(1,2))}

c) What is the relationship between $2^{A \cup B}$ and $2^A \cup 2^B$. Under what circumstances are they equal? **[4]**

d) Suppose that $L \subseteq \{a,b\}^*$ is defined as follows , ^ is in L , for every x and y in L axby and bxay are in L; nothing else is in . Show that L is precisely the set of strings in {a, b}* with equal number of a's and b's. **[4]**

Q-2 Answer the following questions: **[16]**

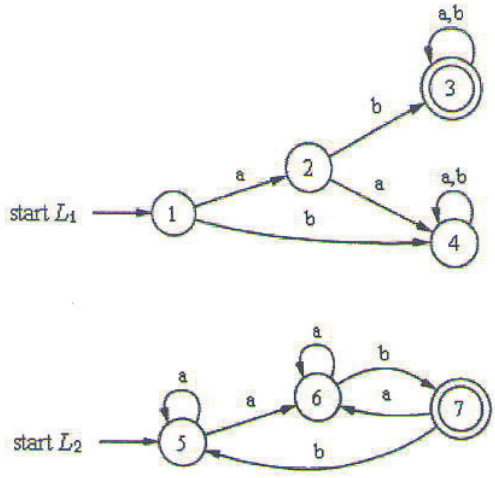
a) For any integer and b with 0<=a<b and every n>=1, show that (b^n-a^n) is divisible by (b-a). **[4]**

b) Explain the Mealy Machine and Moore Machine. Design a Moore Machine to find 2's complement of given binary number. **[6]**

OR

b) $10+(0+11)0^+1$ For the given regular expression draw corresponding NFA-^

c) Let L_1 and L_2 be language represented by the following automata. Construct DFA representing i) $L_1 \cup L_2$ and ii) L1-L2 **[6]**

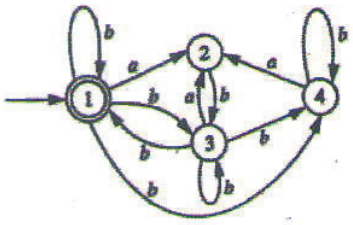


OR

c) What is an equivalence class in a regular language? What is significance of it to prove whether the language is regular or not? Explain with suitable example.

Q-3 Answer the following questions: **[16]**

a) Convert NFA to equivalent DFA. **[4]**



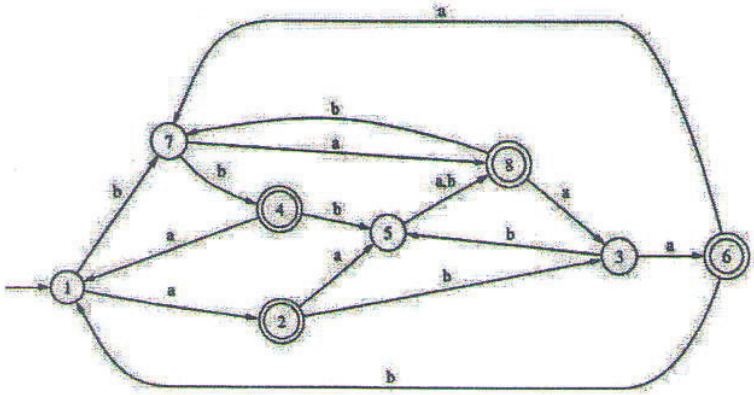
b) For the following sets, write the corresponding regular expression: **[6]**

a. {0,1}

b. {a^2, a^4, a^6, a^8, a^{10},.....}

c. {a^x | x is divisible by 3 or 5}

c) Minimize the DFA **[6]**



SECTION-II

Q-4 Answer the following questions: [18]

a) Describe language generated for following CFGs. [4]

i. $S \rightarrow aSa \mid bSb \mid a \mid b$

ii. $S \rightarrow aSa \mid bSb \mid aAb \mid bAa$
$A \rightarrow aAa \mid bBb \mid a \mid b \mid \wedge$

b) Construct a CFG for the following: [6]

i. Construct a CFG which has equal number of zeros and ones.

ii. $L = \{ a^i b^j c^k \mid i=j \text{ or } i=k \}$

OR

b) Define following terms:
Context free Grammar(CFG), Push Down Automata(PDA), Nullable variable, Regular Grammar

c) What is called normal form of a grammar? What is the utility of normal form? Convert the following into CNF. [8]
$S \rightarrow abAB \mid abB$
$A \rightarrow bAB \mid \wedge$
$B \rightarrow Baa \mid \wedge$

Q-5 Answer the following questions: [16]

a) Design a PDA to accept the language of even length palindrome of {a,b}*. Can we design deterministic PDA for this? Give the reason for the same. [8]

b) Give **top down** PDA for CFG with following productions. [8]
$S \rightarrow S + T \mid T$
$T \rightarrow T * a \mid a$
Give the sequence of moves made by designed PDA to accept a*a+a

OR

b) Give a CFG for the following PDA
$\delta(q_0, a, Z_0) \vdash (q_0, aZ_0)$
$\delta(q_0, a, a) \vdash (q_0, aa)$
$\delta(q_0, c, a) \vdash (q_1, a)$
$\delta(q_1, a, a) \vdash (q_2, \epsilon)$
$\delta(q_2, a, a) \vdash (q_2, \epsilon)$
$\delta(q_2, \epsilon, Z_0) \vdash (q_2, \epsilon)$

Q-6 Answer the following questions: [16]

a) Design turing machine for the following languages over {a,b}* [8]

i. Delete a symbol at the current head position from the string

ii. Odd length palindrome string

b) Design a TM that compute the indicated function. Assume that the natural number n is represented by the string 1^n. [8]
$F(x) = 2x$
