USN | | | | | | | | | | |

10CS56

Fifth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define the following with proper examples:
i) Alphabet ii) Powers of an alphabet. **(03 Marks)**

b. Design the DFA's for the following languages:
i) Set of all strings with at least one 'a' and exactly two 'b's on $\Sigma = \{a, b\}$.
ii) Set of all strings such that number of 1's is even and the number of 0's is a multiple of 3 on $\Sigma = \{0, 1\}$. **(08 Marks)**

c. Design an NFA with no more than 5 states for the following language:
$L = \{abab^n \mid n \geq 0\} \cup \{aba^n \mid n \geq 0\}$ **(03 Marks)**

d. Prove that if $D = (Q_D, \Sigma, \delta_D, \{q_0\}, F_D)$ is the DFA constructed from NFA $N = (Q_N, \Sigma, \delta_N, q_O, F_N)$ by the subset construction, then $L(D) = L(N)$. **(06 Marks)**

2 a. Convert the following ϵ - NFA into an equivalent DFA: **(05 Marks)**

δ	ϵ	a	b	c
$\rightarrow$p	{q, r}	ϕ	{q}	{r}
*q	ϕ	{p}	{r}	{p, q}
r	ϕ	ϕ	ϕ	ϕ

b. Define regular expression and also write the regular expressions for the following languages:
i) $L = \{w \in \{a, b\}^* \mid w$ has exactly one pair of consecutive a's$\}$.
ii) Set of all strings not ending in substring 'ab' over $\Sigma = \{a, b\}$. **(06 Marks)**

c. Prove that if $L = L(A)$ for some DFA A, then there is a regular expression R such that $L = L(R)$. **(06 Marks)**

d. Obtain the regular expression for the following DFA using state elimination technique: **(03 Marks)**

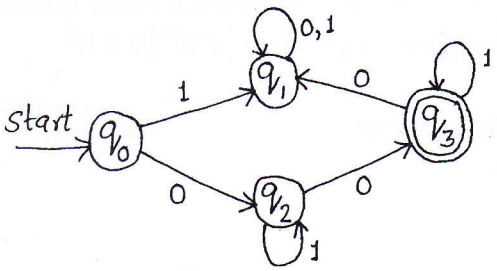

Fig.Q.2(d)

3 a. State and prove pumping lemma for regular languages. **(07 Marks)**

b. Let $\Sigma = \{a, b\}$. Show that the language $L = \{w \in \Sigma^* \mid n_a(w) < n_b(w)\}$ is not regular. **(05 Marks)**

c. Consider the DFA given by the transition table:

δ	a	b
→q_0	q_1	q_2
q_1	q_1	q_3
q_2	q_1	q_2
q_3	q_1	q_4
*q_4	q_1	q_2

i) Draw the table of distinguishabilities for this automaton.
ii) Construct the minimum state equivalent DFA.
iii) Write the language accepted by the DFA. **(08 Marks)**

4 a. Define a Context-Free Grammar (CFG) and also obtain the CFG's for the following languages:

i) $L_1 = \{a^n ww^R b^n | w \in \{0,1\}^* \text{ and } n \geq 2\}$

ii) $L_2 = \{a^k b^m c^n | m + n = k \text{ and } m, n \geq 1\}$

iii) $L_3 = \{w \in \{a\}^* | |w| \bmod 3 \neq |w| \bmod 2\}$. **(10 Marks)**

b. Consider the CFG with productions

$E \rightarrow E * T \mid T$

$T \rightarrow F - T \mid F$

$F \rightarrow (E) \mid 0 \mid 1$

Write the leftmost derivation, rightmost derivation and parse tree for the string '0 – ((1 * 0) – 0)'. **(06 Marks)**

c. Show that the following grammar is ambiguous:

$S \rightarrow SbS$

$S \rightarrow a$. **(04 Marks)**

PART – B

5 a. Design a PDA for the following language : $L = \{ww^R | w \in \{a,b\}+\}$. Also, draw the transition diagram for the constructed PDA. Write the instantaneous description (ID) for the string 'abbbba'. **(08 Marks)**

b. Convert the following CFG to a PDA that accepts the same language by empty stack:

$E \rightarrow E + E | E * E | (E) | I$

$I \rightarrow Ia | Ib | I0 | I1 | a | b$ **(05 Marks)**

c. Define a deterministic PDA (DPDA). Also, design a DPDA along with transition diagram for the following language: $L = \{a^n b^{2n} | n \geq 0\}$. **(07 Marks)**

6 a. Begin with the grammar

$S \rightarrow aAa | bBb | \in$

$A \rightarrow C | a$

$B \rightarrow C | b$

$C \rightarrow CDE | \in$

$D \rightarrow A | B | ab$

i) Eliminate $\in$-productions.
ii) Eliminate any unit productions in the resulting grammar.
iii) Eliminate any useless symbols in the resulting grammar. **(08 Marks)**

b. Define Chomsky Normal Form (CNF). Also, convert the following CFG to CNF:

$S \rightarrow AB \mid a$

$A \rightarrow aab$

$B \rightarrow Ac$. **(06 Marks)**

c. Show that the language $L = \{x \in \{0, 1)^* \mid |x| \text{ is a perfect square } \}$ is not context-free. **(06 Marks)**

7 a. Define a Turing machine. Also, design a Turing machine to accept the set of all palindromes over $\{0, 1\}^*$. Write the transition diagram for the constructed Turing machine and write the sequence of ID's for the input string '1001'. **(12 Marks)**

b. Explain multitape Turing machine and non-deterministic Turing machines with neat block diagrams. **(08 Marks)**

8 Write short notes on the following topics:

a. Applications of finite automata in text search.
b. Inherent ambiguity of context-free languages.
c. Post's correspondence problem.
d. Recursive language and it's relationship with RE and non-RE languages. **(20 Marks)**

* * * * *