(CS-504/CSE&IT/V/2014)

Theory of Computation

Mid-Semester Examination

School of Computer Engineering

KIIT University, Bhubaneswar.

Time: 2 hours

Full Marks: 50

(Answer any five questions including question number 1)

1. Write true or false, and justify your answer briefly. [10]

   (i) Let D be a DFA that accepts a string of length 3, then D has at least 4 states.

   (ii) Let L and M be languages such that both L and LM are regular.
   Then M is also regular.

   (iii) The regular expressions $(0+1+00)^*$ and $(1^*0^*+11)^*$ are equivalent.

   (iv) There exists an infinite regular language L such that $L^* = L^+$.

   (v) If both L and M are non-regular languages, then $L \cup M$ is also non-regular.

2. (a) Let $L = \{u1w : u,\ w \in \{0,1\}^*,\ |u| \geq 2 \text{ and } |w| \leq 2\}$ [5]

   (i) Write a regular expression for the language L

   (ii) Design an NFA that accepts L

   (iii) Design a DFA that accepts L.

   (b) Convert the following NFA to a DFA. [5]

δ	λ	a	b
$\rightarrow q_0$	q_1	Φ	q_2
q_1	$\{q_2, q_3\}$	$\{q_0, q_4\}$	Φ
q_2	Φ	Φ	q_4
q_3	Φ	q_4	Φ
$*\ q_4$	q_3	Φ	Φ

3. (a) Write regular expressions for the following languages over the alphabet $\{a, b\}$. [5]

   (i) The set of all strings starting with aa and ending with aa

   (ii) The set of all strings not containing the substring ab

   (iii) The set of all strings containing even number of b's

   (iv) $\{a^m b^n : m+n \text{ is odd }\}$

   (v) The set of all strings of length at least 50 and at most 90.

(b) Let $\Sigma = \{a, b\}$, and L be the language of all strings that contain neither aa nor bb as a substring. [5]

(i) Design an NFA that accepts L.

(ii) Design a DFA that accepts L.

(iii) Write a regular expression for the language L.

4. (a) State the pumping lemma for regular languages. [5]

Prove that the language $L = \{a^n : n \text{ is a prime number}\}$ is not regular.

(b) (i) Design an NFA with four states that accepts the language of the regular expression $(01 + 011 + 0111)^*$. [5]

(ii) What languages do the regular expressions Φ^* and $a\Phi$ denote?

5. (a) Design a DFA that accepts the language $L = \{w : cab \text{ is not a substring of } w\}$ over the alphabet $\{a, b, c\}$. Convert your DFA to a regular expression using the state-elimination method. [5]

(b) Convert the following regular expressions to NFA . [5]

(i) $(a + b)^*ba$

(ii) $bb(a + b)^*a$

6. (a) Consider the following DFA: [5]

δ	a	b
$\rightarrow p_0$	p_1	p_5
p_1	p_0	p_2
$* p_2$	p_1	p_3
p_3	p_3	p_1
p_4	p_3	p_4
$* p_5$	p_4	p_3

(i) Compute the blocks of indistinguishable states.

(ii) Construct the equivalent minimal DFA.

(b) (i) What do you mean by indistinguishable pair of states in a DFA. Illustrate with an example. [5]

(ii) Is the distinguishability relation of states of a DFA transitive?.