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Formal Languages & Automata Theory/CS-3003/CSE&IT/V/2015

Mid-Semester Examination
School of Computer Engineering
KIIT University, Bhubaneswar.

Time: 2 hours **Full Marks: 25**

(Answer any five questions including question number 1.)

1. Write true or false, and justify your answer briefly. [5]

   (i) Let A be a DFA that accepts all nonempty strings of even length over the alphabet $\{a, b, c, d\}$, then the DFA A has at least 3 states

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

   (iii) The regular expressions $(a+b)^*b(a+b)^* + a^*$ and $(b + .ab + a)^*$ are equivalent

   (iv) Two DFA are equivalent if they have the same number of states

   (v) A language L is regular if $\overline{L}$ is a finite set.

2. (a) Let L be the language of all binary strings that contain 000 or 111 as a substring [2.5]
   (i) Design an NFA that accepts L
   (ii) Design a DFA that accepts L

   (b) Covert the following NFA to an equivalent DFA: [2.5]

δ	λ	a	b	c
$\rightarrow A$	B	B	Φ	Φ
B	Φ	Φ	C	$\{B, E\}$
C	Φ	Φ	Φ	D
D	F	Φ	Φ	D
E	Φ	Φ	D	Φ
$*F$	Φ	Φ	Φ	Φ

3. (a) Write regular expressions for the following languages over the alphabet $\{a, b\}$ [2.5]
   (i) The set of all strings not ending with ab
   (ii) $\{w : |w| \neq 3\}$
   (iii) The set of all strings starting with ba and ending with ab
   (iv) The set of all strings of length at least four with b in the second position and a in the fourth position
   (v) $\{a^m b^n : m \geq 4,\ n \leq 3\}$

(b) Let $\Sigma = \{a, b\}$, and L be the language of all strings starting and ending with different symbols. That is, start symbol of each string is different from its end symbol [2.5]

(i) Design an NFA that accepts L.

(ii) Design a DFA that accepts L.

4. (a) State the pumping lemma for regular languages. Prove that the language $L = \{0^n 1^{n+1} : n \geq 1\}$ is not regular. [2.5]

(b) Let L and M be regular languages. Show that the languages $L \cup M$ and LM are regular. [2.5]

5. (a) Convert the following DFA to a regular expression using the state-elimination technique. [2.5]

δ	a	b
$\rightarrow p$	q	r
q	s	r
r	q	s
$*s$	s	s

(b) Convert the following regular expressions to NFA [2.5]

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

(ii) $ab(ab)^*(a+b)aa$

6. (a) Construct minimum-state DFA equivalent to the following DFA [2.5]

δ	0	1
$\rightarrow A$	B	F
B	A	F
C	G	A
D	H	B
E	A	G
$*F$	H	C
$*G$	A	D
$*H$	A	C

(b) Prove the following [2.5]

(i) Indistinguishability is a transitive relation

(ii) Distinguishability is not a transitive relation.