**IS416**

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M S RAMAIAH INSTITUTE OF TECHNOLOGY

(AUTONOMOUS INSTITUTE, AFFILIATED TO VTU)

BANGALORE – 560 054

SEMESTER END EXAMINATIONS – MAY / JUNE 2014

Course & Branch : **B.E. – INFORMATION SCIENCE & ENGG.** Semester : **IV**
Subject : **Finite Automata and Formal Languages** Max. Marks : **100**
Subject Code : **IS416** Duration : **3 Hrs**

Instructions to the Candidates:

- Answer one full question from each unit.

UNIT – I

1. a) Define the terms with an example for each: ϵ -closure, Alphabet, Strings and Language (10)
b) Write the regular expressions for the following languages: (10)
 - i. $L_1 = \{x \mid x \text{ has either } 001 \text{ as substring or } 11 \text{ as a substring}\}.$
 - ii. $L_2 = \{x \in \{0,1\}^* \mid x \text{ has the first and the last bit the same}\}.$
 - iii. $L_3 = \text{Set of all strings over } \{a, b, c\} \text{ in which } ac \text{ does not occur as a substring.}$
 - iv. $L_4 = \text{Set of binary strings with exactly one pair of consecutive 0's in them.}$
 - v. $L_5 = \text{Set of binary strings containing no more than two 0's.}$

2. a) Design a DFA to accept the following languages: (05)
 - i. Strings of 0's and 1's with even number of 1's and the number of 0's are multiples of 3.
 - ii. Strings of 0's and 1's with odd number of 1's.
b) Define ϵ -NFA. Consider the following ϵ -NFA: (10)

δ	a	b	ϵ
$\rightarrow q_0$	q_1	\emptyset	-
$*q_1$	q_1	\emptyset	q_2
q_2	\emptyset	q_0	-

- i. Compute the ϵ -closure of all the states
 - ii. Convert it into its equivalent DFA
- c) Define the language of NFA and bring out the applications of DFA. (05)

UNIT – II

3. a) Define string homomorphism with an example. Prove that "If L is a regular language over alphabet Σ , and h is a homomorphism on Σ , then h(L) is also regular" (10)
b) Convert the following regular expressions to automata: (10)
 - i. $(aa)^*(bb)^* + a(aa)^*b(bb)^*$
 - ii. $(a+b)^*cd^*e$
 - iii. $(ab+c^*)^*b$
 - iv. $a^*+b^*+c^*$



4. a) Define the term "distinguishable states". Minimize the following DFA: (10)

Δ	0	1
$\rightarrow q_0$	q_1	q_3
q_1	q_2	q_4
q_2	q_1	q_4
q_3	q_2	q_4
$*q_4$	q_4	q_4

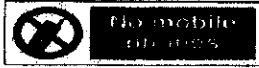
- b) Prove that if $L=L(A)$ for some DFA A , then there is a regular expression R such that $L=L(R)$. (10)

UNIT - III

5. a) Define Context Free Grammar (CFG) providing descriptions to its components. Write the CFG for the following languages: (10)
- $L(G_1)=\{w \in \Sigma^* \mid |w| \text{ and } w \text{ has equal number of a's and b's}\}$
 - $L(G_2)=\{a^n b^m \mid n \leq m-1\}$
- b) State and prove the pumping lemma for context free languages. (10)
6. a) Consider the grammar: (10)
- $S \rightarrow ABC \mid BaB$
 $A \rightarrow aA \mid BaC \mid aaa$
 $B \rightarrow bBb \mid a \mid D$
 $C \rightarrow CA \mid AC$
 $D \rightarrow \epsilon$
- Eliminate ϵ -productions.
 - Eliminate any unit productions in the resulting grammar.
 - Eliminate any useless symbols in the resulting grammar.
 - Put the resulting grammar into Chomsky Normal Form.
- b) Explain the following with an example for each: (10)
- Constructing Parse trees
 - Leftmost and Rightmost derivation
 - The Yield of a Parse tree

UNIT - IV

7. a) With a neat diagram, explain the working principle of PDA. Construct NPDA that accepts the language $L=\{a^n b^m \mid n \leq m \leq 3n\}$ on $\Sigma \{a,b\}$. (10)
- b) If $L=L(M)$ for some NPDA M , then L is a context free language. (10)
8. a) Define the language of PDA by final state and by empty stack. (04)
- b) Let L_1 be a context free language and L_2 be a regular language. Then prove that $L_1 \cap L_2$ is also context free language. (08)
- c) Convert the following grammar to its equivalent PDA. (08)
- $S \rightarrow aA$
 $A \rightarrow aABC \mid bB \mid a$
 $B \rightarrow b$
 $C \rightarrow c$



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UNIT - V

9. a) Give the formal definition of Turing Machine. Design a Turing machine, M to accept the language $L(M) = \{0^n 1^n \mid n \geq 1\}$ and trace the same for the string 0011. (12)
- b) Prove that "Every language accepted by multi tape TM is recursively enumerable". (08)
10. a) Write short notes on: (10)
- i. Multitape turing machine
 - ii. Halting problem of turing machine
- b) Define the language of a Turing machine. Design a Turing machine to compute the function monus(Proper subtraction) and is defined by $m \text{ monus } n = \max(m-n, 0)$. (10)
