(c) Design a PDA to accept the language $L = \{wcw^R \mid w$ belongs to $(a, b)^+\}$ by empty stack. 4

(d) Prove using pumping lemma that the following language is not CFL : 3

$$L = \{a^i b^i c^i \mid i >= 1\}$$

9. (a) Design a TM over $\{a, b, c\}$ to accept the language $L = \{ww^R \mid w$ belongs to $(a, b)^+\}$. 7

(b) Design a Turing machine for the regular expression 011^*. 7

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Code : 051611

B.Tech 6th Semester Exam., 2014

FORMAL LANGUAGES AND AUTOMATA THEORY

Time : 3 hours Full Marks : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct option of the following (any *seven*) : 2×7=14

(a) The output of the Moore machine depends

(i) only on present state

(ii) only on current input symbol

(iii) both on present state and current input symbol

(iv) None of the above

(b) The logic of pumping lemma is a good example of

(i) the pigeon-hole principle

(ii) the divide and conquer technique

(iii) recursion

(iv) iteration

(c) Recursively enumerable languages are not closed under
  (i) union
  (ii) intersection
  (iii) complementation
  (iv) concatenation

(d) The language

$L = \{a^n b^n a^n, \text{ where } n = 1, 2, 3, \cdots\}$

is a
  (i) regular language
  (ii) context-free language
  (iii) non-context-free language
  (iv) None of the above

(e) A language L is denoted by a regular expression

$L = (x)^* (x | yx^*)$

Which of the following is not a legal string within L?
  (i) x
  (ii) $xyxyx$
  (iii) xyx
  (iv) None of the above

(f) Context-free languages are not closed under
  (i) union
  (ii) intersection
  (iii) concatenation

(Continued)

(g) Recursive languages are
  (i) a proper superset of CFLs
  (ii) always recognizable
  (iii) also called type 0 languages
  (iv) recognizable by Turing machines

(h) Choose the incorrect statement :
  (i) Every subset of a countable set is countable
  (ii) The class of DPDA is not countable
  (iii) The class of TMs is countable
  (iv) The class of LBA is countable

(i) Which of the following statements is true?
  (i) The language $\{a^n \mid n \text{ is prime}\}$ is regular language
  (ii) The union of 2 recursive languages is recursive
  (iii) Recursive enumerable languages are closed under complementation
  (iv) Recursive languages are not closed under complementation

(j) In case of TM, by reading input x, TM
  (i) may go to halt-final state
  (ii) may go to halt-non-final state
  (iii) may go to infinite loop
  (iv) All of the above

(Turn 0

2. *(a)* Obtain the regular expression for the following sets : 2×5=10

(i) Set of strings over $\Sigma = \{a, b\}$ with at least one a and at least one b

(ii) Set of strings over $\Sigma = \{0, 1\}$ of alternate 0's and 1's

(iii) $L = \{a^{2n+1} \mid n >= 0\}$

(iv) Set of strings over $\Sigma = \{a, b, c\}$ where all runs of a's have lengths that are multiples of three

(v) Set of all possible strings of length four over $\Sigma = \{0, 1\}$

(b) Differentiate between Moore and Mealy machines. 2

(c) Differentiate between NFA and DFA. 2

3. *(a)* Construct NFA equivalent to the following regular expression : 4

$$10 \mid (0 \mid 11)0^*1$$

(b) Construct an NFA for the following set : 5

Set of all strings over $\Sigma = \{0, 1\}$ containing at least two 0's

(c) Construct NFA for the set of strings over $\Sigma = \{0, 1\}$ of alternate 0's and 1's.

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4. *(a)* Construct a DFA for the regular expression $r = (ab \mid ba)^* aa(ab \mid ba)$. 7

(b) Find out the regular expression for the following FA : 7

Current States	I/P Symbol	
	a	*b*
p	*p, q*	...
q	*r*	*q, p*
r	*q*	...

Here, r is the final state.

5. *(a)* Construct a Moore machine equivalent to the following Mealy machine : 5

PS	Input Symbol			
	$a = 0$		$a = 1$	
	NS	o/p	NS	o/p
q1	*q3*	0	*q2*	0
q2	*q1*	1	*q4*	0
q3	*q2*	1	*q1*	1
q4	*q4*	1	*q3*	0

(b) Prove the following two properties : 2½×2=5

(i) Regular sets are closed over the union operation

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(ii) Regular sets are closed over the intersection operation

(c) Show with the help of pumping lemma that the following language is not regular : 4

$L = \{a^p \mid p \text{ is prime number}\}$

6. (a) Give the CFG for the following languages : 3×2=6

(i) $L = \{a^n b^m a^n \mid n >= 0, m >= 1\}$

(ii) Set of strings over $\Sigma = \{a, b\}$ with exactly twice as many a's and b's

(b) Find a CFG for the following regular expression : 4

$r = (baa \mid abb)^*$

(c) Let G be a context-free grammar, which is defined as

$S \rightarrow aSb \mid ab$

Find the CFL generated by G. 4

7. (a) Find a regular grammar for the following regular expression : 4

$r = (abbb \mid ba)^* ab$

(b) Determine a CFG without unit production equivalent to the CFG given below :

$S \rightarrow ABCD$ 3

$A \rightarrow a$ 3

$B \rightarrow C \mid b$ 3

$C \rightarrow D$

$D \rightarrow c$

(c) Find the CNF (Chomsky Normal Form) for the following CFG :

$S \rightarrow aAbB$ 3

$A \rightarrow Ab \mid b$ 3

$B \rightarrow Ba \mid a$ 3

(d) Eliminate the null productions from the following CFG : 4

$S \rightarrow ABA$

$A \rightarrow aA \mid \varepsilon$

$B \rightarrow bB \mid \varepsilon$

S→ABA| B |ABA|A|ε

A → aA

B → bB .

8. (a) Prove that the CFL's are not closed under intersection.

(b) Design a PDA to accept the language $L = \{a^n b^{2n} \mid n >= 1\}$ by empty stack.