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(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

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(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)

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(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

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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

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

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(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.

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Code : 051611

B.Tech 6th Semester Exam., 2015

FORMAL LANGUAGES AND AUTOMATA THEORY

Full Marks : 70

Time : 3 hours

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. Define any *seven* of the following : 2×7=14

(a) Applications of automata theory

(b) Finite automata

(c) Transition graph

(d) Epsilon transition

(e) Regular expression

(f) Regular language

(g) Turing acceptable

(h) Mealy machine

(i) Reducibility

(j) Enumerable language

2. *(a)* Design an FA that accepts set of strings containing exactly four 1's in every string over alphabets $\Sigma = \{0, 1\}$. 7

(b) Design an NFA for the language L = all strings over {0, 1} that have at least two consecutive 0's or 1's. 7

3. *(a)* Design a deterministic finite automata which accepts set of strings such that every string containing "00" as sub-string but not "000" as sub-string. 7

(b) Show that if L is regular, so $L - \{\epsilon\}$ will be also regular. 7

4. *(a)* Write a regular expression over alphabets $\{a, b, c\}$ contains at least one "a" and at least one "b". 7

(b) Prove that $L = \{0^1 1^m \,!n <= m\}$ is not regular language. 7

5. *(a)* What do you mean by closer properties of regular language? Define some important closer properties. 7

(b) Prove that, if $L1$ and $L2$ is regular, then $L1 \cup L2$ is also regular language. 7

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6. (a) Explain ambiguities in context free grammar and languages. 7

(b) Find context free grammar for the regular expression $r = (a + b)^*$. 7

7. (a) Show that the following grammar is ambiguous : 7

$S \rightarrow AB \mid aaB$

$A \rightarrow a \mid Aa$

$B \rightarrow b$

(b) Define parse tree with its applications in finite automata. 7

8. (a) What do you mean by push down automata? Explain its move. 7

(b) Using pumping lemma, prove that language $L = \{WW / W \in \{a, b\}\}$ is not context free. 7

9. (a) Explain turing machine for computing function. 7

(b) Write in brief about NP complete problem. 7

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B.Tech 6th Semester Exam., 2016

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 answer for any *seven* of the following : 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

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(c) Regular languages are closed under
(i) union
(ii) intersection
(iii) complementation
(iv) All of the above

(d) The language $L = \{a^n b a^n$ where $n = 1, 2, 3, ...\}$ 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 $L = (ab \mid ba)\, abb$. Which of the following is not a legal string within L?
(i) *ababb*
(ii) *abbaabb*
(iii) *baabb*
(iv) None of the above

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

(Continued)

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(g) Context-free languages are
(i) a proper superset of regular languages
(ii) recognizable by PDA
(iii) also called type 2 languages
(iv) All of the above

(h) Choose the incorrect statements :
(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 $\{a^n \mid n$ 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.

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(j) In case of TM, in which of the following cases a string will be accepted?

(i) Entire string has been consumed and TM halts in the final state

(ii) Entire string has been consumed and TM halts is the non-final state

(iii) Entire string has not been consumed and TM halts is in any state

2. (a) Obtain the regular expression for the following sets : 2½×4=10

(i) Set of strings over $\Sigma = \{a, b\}$ with exactly two a

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

(iii) Set of strings over $\Sigma = \{a, b, c\}$ such that every string contains a substring ccc

(iv) $L = \{a^x \mid x \text{ is divisible by 3 or 5}\}$

(b) Show that $(ab)^* \neq a^* b^*$.

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

$$r = (ab \mid ba)^* \; aa(ab \mid ba)^*$$

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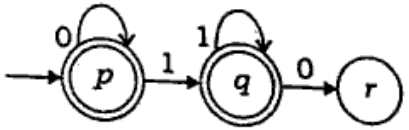
(b) Construct an NFA with ϵ moves for the regular expression $r = a(a + b)^*$. 5

(c) Construct an NFA for the set of all strings over $\Sigma = \{a, b\}$ with exactly two a

4. (a) Construct a DFA for the regular expression $r = 0^*1^*2^*$.

(b) Find out the regular expression for the following transition diagram :



5. (a) Prove the following two properties : 3×2=6

(i) Regular sets are closed over the concatenation operation

(ii) Regular sets are closed over the complement operation

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

$$L = \{ww \mid w \in (0, 1)^*\}$$

(c) Represent the language that contains strings over $\Sigma = \{0, 1\}$ and has even number of 0's. 4

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6. (a) Give the CFG for each of the languages defined by the following regular expressions : 3×3=9

(i) a^*b

(ii) $(ab)^*$

(iii) $(baa+abb)^*$

(b) Construct a CFG for the set of non-negative odd integers. 5

7. (a) For the grammar G, which is defined as

$$S \to aB \mid bA$$
$$A \to a \mid aS \mid bAA$$
$$B \to b \mid bS \mid aBB$$

where S is the starting symbol, show the leftmost derivation, rightmost derivation and parse tree for the string 'abbbaa'. 9

(b) Determine a CFG without unit production equivalent to the CFG given below : 5

$$S \to a \mid Xb \mid aYa \mid b \mid aa$$
$$X \to Y$$
$$Y \to b \mid X$$

8. (a) Find the CNF (Chomsky Normal Form) for the the following CFG : 5

$$S \to ABA$$
$$A \to aA \mid \in$$
$$B \to bB \mid \in$$

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

$$S \to Xa$$
$$X \to aX \mid bX \mid \in$$

(c) Convert the following grammar to GNF : 5

$$A_1 \to A_2A_3$$
$$A_2 \to A_3A_1 \mid b$$
$$A_3 \to A_1A_2 \mid a$$

9. (a) Design a PDA that accepts the language $L = \{wcw^R \mid w \in (0|1)^*\}$. 4

(b) Design a PDA that accepts the language $L = \{a^n b^m a^n \mid m, n > 0\}$. 4

(c) Design a TM that recognizes strings containing equal number of 0's and 1's. 6

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Code : 051611

B.Tech 6th Semester Examination, 2017

Formal Languages and Automata Theory

Time : 3 hours *Full Marks : 70*

Instructions :

*(i) There are **Nine** Questions in this Paper.*

*(ii) Attempt **Five** questions in all.*

*(iii) **Question No. 1 is Compulsory.***

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

1. Choose the correct alternatives for ***any seven*** of the following: 7×2 = 14

(i) The output of the Moore Machine depends

(a) only on present state

(b) only on current input symbol

(c) both on present state and current input symbol

(d) none of the above

(ii) The logic of Pumping lemma is a good example of

(a) the pigeon-hole principle

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(b) divide and conquer technique

(c) recursion

(d) iteration

(iii) Recursively enumerable languages are not closed under

(a) union

(b) intersection

(c) complementation

(d) concatenation

(iv) The language L={a"b"a" where n=1,2,3.....} is a

(a) regular language

(b) context-free language

(c) non-context-free

(d) none of the above

(v) A language L is denoted by a regular expression:

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

(a) x

(b) xyxyx

(c) xyx

(d) none of the above

(vi) Context free languages are not closed under

(a) union

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(b) intersection

(c) concatenation

(vii) Recursive languages are

(a) a proper superset of CFLs.

(b) Always recognizable

(c) Also called type 0 languages

(d) Recognizable by Turing Machines

(viii) Choose the incorrect statements

(a) Every subset of a countable set is countable

(b) The class of DPDA is not countable

(c) the class of TMs is countable

(d) The class of LBA is countable

(ix) Which of the following statements is true?

(a) The language $\{a^n|\ n \text{ is prime}\}$ is regular language

(b) The union of 2 recursive languages is Recursive.

(c) Recursive enumerable languages are closed under complementation.

(d) Recursive languages are not closed under complementation

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(x) In case of TM, by reading input x, TM

(a) may go to halt-final state

(b) may go to halt-non final state

(c) may go to infinite loop

(d) All of the above

2. (a) Obtain the regular expression for the following sets: 4×3=12

(i) Set of strings over $\sum = \{a,b,c\}$ with exactly one *c*.

(ii) Set of strings over $\sum = \{0,1\}$ containing all possible strings of length four.

(iii) Language over $\sum = \{0,1\}$ containing all possible combinations of 0's and 1's but not having two consecutive 0's.

(iv) Language over $\sum = \{0,1\}$ consisting of all string with at least two consecutive 0's.

(b) Describe in simple English the language represented by the regular expression $r = (1+10)^*$. 2

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

$10|(0|11)0^*1$

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(b) Construct a NFA with $\in$ moves for the regular expression $r = (a^* + b^*)$. 5

(c) Construct NFA for the Set of all strings over $\sum = \{0,1\}$ with alternate 0's and 1's. 5

4. (a) Construct a DFA for the regular expression r = (a|b)* aa (ab|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) Prove the following two properties: 3×2=6

(i) Regular sets are closed over the union operation

(ii) Regular sets are closed over the intersection operation

(b) Show with the help of pumping lemma that following languages are not regular: 4×2=8

(i) $L=\{0^{i^2} \mid i \text{ is an integer, } i>=1\}$

(ii) $L = \{a^n b^n \mid n > 0\}$

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6. (a) Give the CFG for each of the languages defined by the following regular expressions: 3×3 = 9

   i. ab^*

   ii. a^*b^*

   iii. $(baa+abb)^*$

   (b) Construct a CFG for the following language set:

   $L = \{a^{2n} b^n \mid n>=1\}$

7. (a) For the grammar G, which is defined as:

   $S \rightarrow aB|bA$

   $A \rightarrow a|aS|bAA$

   $B \rightarrow b|bS|aBB$

   Where *S* is the starting symbol, show the leftmost derivation, rightmost derivation and parse tree for the string *'bbaaba'*. 9

   (b) Determine a CFG without unit production equivalent to the CFG given below. 5

   $S \rightarrow Abb$

   $A \rightarrow Bb$

   $B \rightarrow Sa$

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8. a) Find the CNF (Chomsky Normal Form) for the following CFG: 5

   $S \rightarrow aSa|bSb|a|b|aa|bb$

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

   $A \rightarrow aBb|bBa$

   $B \rightarrow aB|bB|\in$

   (c) Convert the following grammar to GNF: 5

   $S \rightarrow ABA|AB|BA|AA|A|B$

   $A \rightarrow aA|a$

   $B \rightarrow bB|b$

9. (a) Design a PDA that accepts all palindrome strings over $\sum = \{a,b\}$. 5

   (b) Design a PDA that accepts the language $L = \{a^{2n} | n > 0\}$. 5

   (c) Show that $L = \{a^p \mid p \text{ is prime}\}$ is not a context-free language. 4

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