(Pages : 2)

FOURTH SEMESTER B.E. (COMPUTER SCIENCE ENGINEERING/INFORMATION SCIENCE ENGINEERING) DEGREE EXAMINATION

FINITE AUTOMATA AND FORMAL LANGUAGES

Time : Three Hours Maximum : 100 Marks

Answer any **five** *questions.*
All questions carry equal marks.

1. (a) Define grammar, derivation, sentential forms and give *one* example of each. (6 marks)

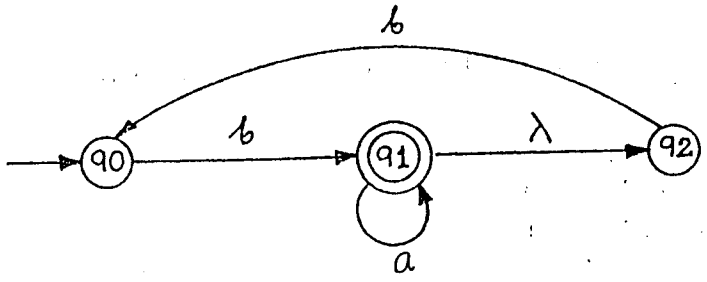
   (b) Write a grammar for generating language

   $$L = \{w / n_a(w) = n_b(w) \times w \in (a, b)^*\},$$

   where $n_a(w)$ = number of a's in w and $n_b(w)$ = number of b's in w. (5 marks)

   (c) Define DFA and write a DFA, which will accept set of all strings having substring abb over $\Sigma = \{a, b\}$. (9 marks)

2. (a) Write a procedure to convert an NFA to a = DFA and convert the following NFA to DFA $\Sigma = \{a, b\}$.



(12 marks)

   (b) Define a regular expression and find a regular expression for the language

   $$L = \{w / w \in (0, 1)^* \text{ and } w \text{ has no pair of consecutive zeros}\}.$$

(8 marks)

   (a) Show that the regular languages are closed under complementation. (6 marks)

   (b) Construct an NFA that accepts the following languages :—

   (i) $L(aa^* + aba^*b^*)$.

   (ii) $L(ab(a + ab)^*(a + aa))$.

(8 marks)

   (c) Define right quotient and find a DFA to accept right quotient of L_1/L_2, where

   $$L_1 = \{a^n b^m \mid n \geq 1, m \geq 0\} \cup \{ba\}$$

   $$L_2 = \{b^m \mid m \geq 1\}$$

(6 marks)

Turn over

4. (a) Define context free grammar and show derivation tree, right most derivation $(a + b) * c$ for the following grammar :

$$E \rightarrow E + T \mid T, T \rightarrow T * F \mid F, F \rightarrow (E) \mid a \mid b \mid c.$$

(6 mar

(b) Give procedure to eliminate useless symbols and eliminate λ-productions, u productions and useless symbols from the following grammar :—

$$S \rightarrow a \mid aA \mid B \mid C,\ A \rightarrow aB \mid \lambda,\ B \rightarrow Aa$$
$$C \rightarrow cCD,\ D \rightarrow d$$

(14 mark

5. (a) Define Greibach and Chomsky normal forms and convert the following grammar Chomsky normal form :—

$$E \rightarrow E + E \mid E * E \mid (E) \mid a \mid b \mid c$$

(10 mark

(b) Define non-deterministic PDA and write PDA for $L = \{a^n b^m c^{n+m} \mid n \geq 0, m \geq 0\}$ sho by instantaneous description how string *bbcc* is accepted.

(10 marks

6. (a) Write a NPDA for $L = \{ww^R \mid w \in \{0, 1\}^+\}$. (10 marks

(b) Find a context free grammar that generates the language accepted by NPDA

$$M = (\{90, 91\}, \{a, b\}, \{A, Z\}, \delta, 90, Z, \{91\})$$

with transitions

$$\delta\ (90, a, Z) = \{(90, AZ)\}$$
$$\delta\ (90, b, A) = \{(90, AA)\}$$
$$\delta\ (90, a, A) = \{(91, \lambda)\}$$

(10 marks)

7. (a) State and prove pumping lemma for context-free languages. (8 marks)

(b) Define turing machine and construct turing machine for

$$L = \{a^n b^n c^n \mid n \geq 1\}.$$

(12 mark

8. Write short notes on :

(a) Linear bounded automata.
(b) Unrestricted grammars.
(c) The Chomsky hierarchy.
(d) The post-correspondence problem.

(4 × 5 = 20 marks)

(Pages 2) CSI—45

RTH SEMESTER B.E. (COMPUTER SCIENCE ENGINEERING/INFORMATION SCIENCE ENGINEERING) DEGREE EXAMINATION, MARCH 2001

FINITE AUTOMATA AND FORMAL LANGUAGES

: Three Hours Maximum : 100 Marks

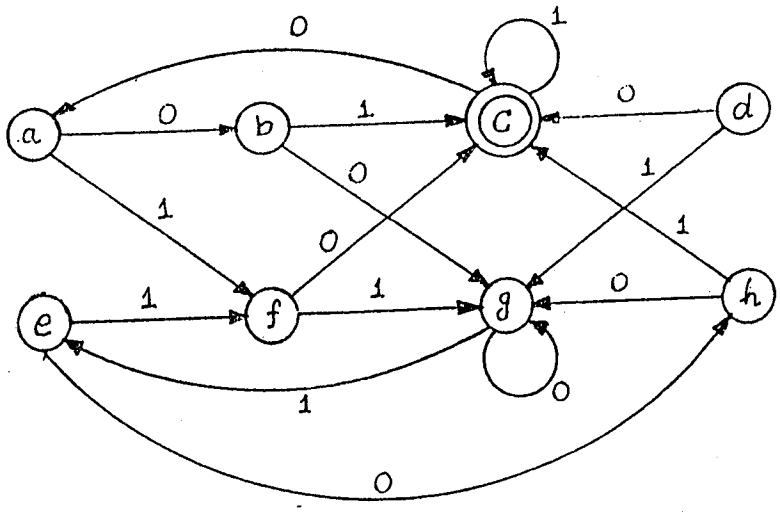
Answer any **five** *full questions.*
All questions carry equal marks.

(a) Define the terms alphabet, string, prefix, suffix and language, give examples to each. (5 marks)

(b) Define a DFA. Write a DFA which will recognize all strings except those containing the substring 00 over the $\sum = \{0, 1\}$. (10 marks)

(c) Explain Chomskian hierarchy. (5 marks)

2. (a) Give a procedure to find the minimal state DFA. Use it to find minimal state DFA for the following DFA.



(12 marks)

(b) Define Regular expression. Prove that for all languages defined by a regular expression there exists an equivalent, NFA which accents exactly the same language. (8 marks)

3. (a) State and prove pumping lemma for regular languages. Use it, to prove that $L = \{ a^n b^n \mid n \geq 0 \}$ is not regular. (15 marks)

(b) S.T. the regular languages are closed under complementation. (5 marks)

Turn over

4. (a) What are CFG's ? Give a CFG for the language $L = \{ a^n b^{2n} \mid n \geq 0 \}$.

(8 marks)

(b) Convert the following CFG into CNF :—

$S \rightarrow bA \mid aB$

$A \rightarrow bAA \mid aS \mid a$

$B \rightarrow aBB \mid bS \mid b$

(6 marks)

(c) Given the grammar G as follows :

$S \rightarrow aAS \mid a$

$A \rightarrow sbA \mid SS \mid ba$

find the (i) Left most derivation ; (ii) Right most derivation ; and (iii) Parse tree, for the string *aabbaa*.

(6 marks)

5. (a) Define PDA. Describe the acceptance by "final state" and the acceptance by "empty stack".

(8 marks)

(b) Design a PDA for the language $L = \{ a^n b^n \mid n \geq 0 \}$. Give the trace for the *i/p aaabbb*.

(12 marks)

6. (a) Prove that the family of CFL's are not closed under intersection and complementation.

(10 marks)

(b) What are ambiguous grammars and inherently ambiguous grammars, give an example for each ?

(5 marks)

(c) Distinguish between DPDA and NPDA. (5 marks)

7. (a) Define a Turing machine. Give a Turing machine to implement, the total recursive function "multiplication". The Turing machine starts with $O^m \mid O^n$ on its tape and ends with O^{mn} surrounded by blanks.

(15 marks)

(b) What are Recursive and recursively enumerable languages ? Are they same ?

(5 marks)

8. Write short notes on :

(a) Halting problem of Turing machine.
(b) Application of CFG.
(c) Multi-tape Turing machines.
(d) Post-correspondence problem.

(4 × 5 = 20 marks)

CSI45

2 Reg. No. | | | | | | | | | | |

Fourth Semester B.E. Degree Examination, August 2001

Computer Science / Information Science

Finite Automata & Formal Languages

Time: 3 hrs.] [Max.Marks: 100

Note: *Answer any FIVE questions.*
All questions carry equal marks

1. (a) Design an automaton for serial binary adder. **(5 Marks)**

(b) Give a simple description of the language generated by the grammer with productions

$$S \rightarrow aA/\lambda$$
$$A \rightarrow bS$$

(5 Marks)

(c) Describe the procedure to convert a NFA to DFA and convert the NFA in Fig. (1) to DFA.

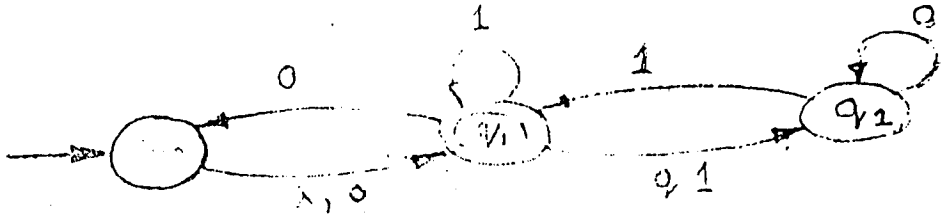


Fig (1)

(10 Marks)

2. (a) Describe the method to minimize the states of a DFA and do the same for the DFA of Fig. (2).

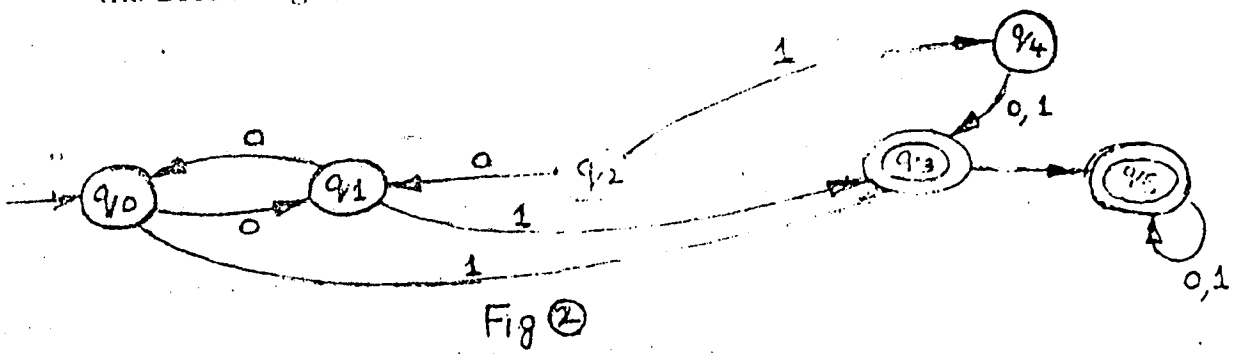


Fig (2)

(10 Marks)

(b) Define Regular Expression and language denoted by any regular expression. **(4 Marks)**

(c) Find a regular expression for the language
$L = \{w \in \{0,1\}^* : w$ has no pairs of consecutive zeros $\}$ **(6 Marks)**

Contd.... 2

3. (a) Find the NFA that accepts the language

$$L(ab^*aa + bba^*ab)$$ (5 Marks)

(b) Construct right and left linear grammer for the language

$$L = \{a^n b^m : n \geq 2, m \geq 3\}$$ (7 Marks)

(c) Let $L_1 = L(a^*baa^*)$ and $L_2 = L(aba^*)$ find L_1/L_2 (8 Marks)

4. (a) Write a leftmost derivation, a rightmost derivation and a derivation tree for the string a^2b^4 with the grammer

$S \rightarrow AB/\lambda$
$A \rightarrow aB$
$B \rightarrow Sb$ (9 Marks)

(b) Show that the grammer given below is ambiguous

$E \rightarrow E + E/E * E|(E)|I$
$I \rightarrow a/b/c$ (6 Marks)

(c) Define $S-$grammer and find $S-$grammer for

$$L(aaa^*b + b)$$ (5 Marks)

5. (a) Remove λ, unit, useles productions from the grammer

$S \rightarrow a/aA/B/C$
$A \rightarrow aB|\lambda$
$B \rightarrow Aa$
$C \rightarrow cCD$
$D \rightarrow ddd$

(b) Construct an rpda for the language

$$L = \{w \in \{a,b\}^* : n_a(\omega) = n_b(\omega)\}$$

and write the moves that it makes for processing the string abba. (10 Marks)

6. (a) Construct an npda that accepts the language generated by the grammer

$S \rightarrow aABB/aAA$
$A \rightarrow aBB/a$
$B \rightarrow bBB/A$ (10 Marks)

(b) Show that the language

$$L = \{\omega\omega : w \in \{a,b\}^*\}$$

is not context Free (5 Marks)

(c) Define Linear context Free grammer and write the pumping Lemma for Linear Languages (5 Marks)

7. (a) Define a Turing machine. Design a Turing machine that accepts $L = \{a^n b^n : n \geq 1\}$ (10 Marks)

(b) Show that the class of Turing machines with stay option is equivalent to the class of standard Turing Machines. (10 Marks)

8. Write short notes on:
   (a) Context Sensitive Grammer & Languages
   (b) Post correspondence Problem
   (c) Chomsky Hierarchy
   (d) Pumping Lemma for Regular Languages (5 X 4 Marks)

Reg. No.

Fourth Semester B.E. Degree Examination, February 2012

Computer Science / Information Science and Engineering

Finite Automata & Formal Languages

Time: 3 hrs.] [Max. Marks : 100

Note: *Answer any FIVE full questions.*
All questions carry equal marks

1. (a) Define the terms - prefix and suffix of a string, productions, sentential form. (4 Marks)

   (b) Write a grammar for the following language

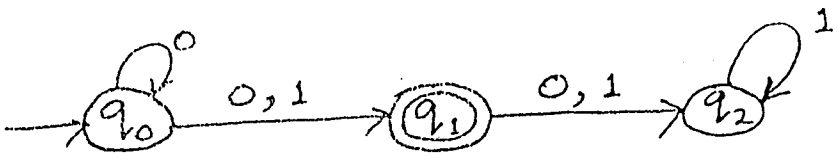
   $$L = \{(ab)^n : n \geq 0\}$$ (4 Marks)

   (c) Compare deterministic and non-deterministic finite automata. (4 Marks)

   (d) Design a DFA that accepts only the language of all strings with 'b' as the second letter on $\Sigma = \{a, b\}$.

   Draw also the transition table and show that the string abaab is accepted by DFA. (8 Marks)

2. (a) Convert the following NFA into an equivalent DFA and minimize the number of states in the DFA. (12 Marks)



   (b) Define regular expression. Construct an NFA for the regular expression $0^* + 1^* + 2^*$. (5 Marks)

   (c) Give a regular expression to denote all strings of 0's and 1's with atleast two consecutive 0's. (3 Marks)

3. (a) State and prove pumping lemma for regular languages. (8 Marks)

   (b) Show that the family of regular languages is closed under intersection and complementation. (6 Marks)

   (c) Show that $L = \{ww^R : w \epsilon \Sigma^*\}$ where $\Sigma = \{a, b\}$ is not regular. (6 Marks)

4. (a) Let G be the grammar

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

   For the string aaabbabbba find a (i) leftmost derivation (ii) rightmost derivation (iii) parse tree (6 Marks)

   (b) If G is the grammar $S \rightarrow SbS \mid a$, show that G is ambiguous. (4 Marks)

Contd.... 2

(c) Eliminate useless symbols and productions from the following grammar.

$S \to aAa, A \to Sb \mid bCC \mid DaA, C \to abb \mid DD, E \to aC, D \to aDA.$ (6 Marks)

(d) Define unit productions and λ productions with examples. (4 Marks)

5. (a) Define CNF and GNF. Convert the following grammar to CNF.

$S \to \sim S \mid [S \supset S] \mid p \mid q$ (S being the only variable). (10 Marks)

(b) Obtain NPDA for the language

$L = \{ww^R : win(0+1)^*\}$.

Show the accessible instantaneous descriptions for the string 001100. (10 Marks)

6. (a) Construct an NPDA corresponding to the grammar

$S \to aA,$
$A \to aABC \mid bB \mid a,$
$B \to b,$
$C \to c,$

Derive a string for is grammar and show the sequence of moves made by NPDA in processing the same string. (10 Marks)

(b) Show that the language.

$L = \{a^n b^n c^n : n \geq O\}$ is not context-free. (5 Marks)

(c) Show that the family of context free languages is not closed under intersection and complementation. (5 Marks)

7. (a) Define a tuning machine. For $\Sigma = \{a, b\}$ design a tuning machine that accepts $L = \{a^n b^n : n \geq 1\}$. Give the computation sequence for the input aabb. (12 Marks)

(b) Define a multitape tuning machine. Show how it can be simulated using single tape tuning machine. (8 Marks)

8. Write short notes on the following:

i) Applications of finite automata.
ii) Linear bounded automata.
iii) Tuning machine Halting problem.
iv) Chomsky Hierarchy. (20 Marks)

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Reg. No.

Fourth Semester B.E. Degree Examination, July/August 2002

Computer Science / Information Science and Engineering

Automata & Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*
All questions carry equal marks

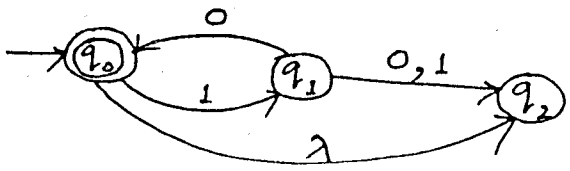
1. (a) Define the terms - string, empty string, reverse of a string and concatenation of two strings with an example for each. **(4 Marks)**

   (b) Define the language accepted by DFA. When is the language called regular? Show that the language $L = \{awa : \omega \in \{a,b\}*\}$ is regular. **(8 Marks)**

   (c) Find grammar for the language $L = \{\omega : n_a(\omega) = n_b(\omega) + 1\}$. Assume $\sum = \{a,b\}$ and let $n_a(\omega)$ and $n_b(\omega)$ denote the number of a's and b's in the string ω respectively. **(5 Marks)**

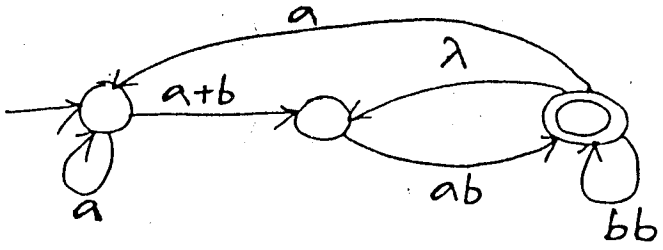
   (d) Give an application of finite automata. **(3 Marks)**

2. (a) Define nondeterministic finite automata. Convert the following NFA into DFA. What is the language accepted by this automaton? **(10 Marks)**



   (b) Define regular expression. Give a regular expression for $L = \{a^n b^m : n \geq 4, m \leq 3\}$ **(5 Marks)**

   (c) For the following generalised transition graph, find an equivalent generalised transition graph with only two states. What is the language accepted by this graph? **(5 Marks)**



3. (a) Show that the family of regular languages are closed under intersection. **(5 Marks)**

   (b) Define homomorphism and homomorphic image. Let $\sum = \{a,b\}$ and $\Gamma = \{a,b,c\}$ and h is defined by $h(a) = ab, h(b) = bbc$. If $\omega = aba$, what is $h(\omega)$? and if $L = \{aa, aba\}$, What is $h(L)$? **(5 Marks)**

Contd.... 2

(c) Define Right-Linear Grammar and Left-Linear Grammar. Construct a DFA that accepts the language generated by the grammar $S \rightarrow abA$, $A \rightarrow baB$, $B \rightarrow aA|bb$. What is the language accepted by this automation? (10 Marks)

4. (a) Let G be the grammar $S \rightarrow aAS|a|SS$, $A \rightarrow SbA|ba$. For the string $aabaa$, find a (i) leftmost derivation (ii) rightmost derivation (iii) derivation tree. (6 Marks)

(b) Define $\lambda-$ productions. Eliminate all $\lambda-$productions from $S \rightarrow AaB|aaB$, $A \rightarrow \lambda$, $B \rightarrow bbA|\lambda$. (8 Marks)

(c) Define Greibach Normal Form. Convert the following grammar. $S \rightarrow ABb|a$, $A \rightarrow aaA|B$, $B \rightarrow bAb$ into Greibach Normal Form. (6 Marks)

5. (a) Eliminate all useless symbols and productions from the grammar $S \rightarrow AS|CD|bB|a$, $A \rightarrow aA|a$, $B \rightarrow bB|bC$, $C \rightarrow eB$, $D \rightarrow dD|d$. (10 Marks)

(b) Define Nondeterministic Pushdown Automata. Design a PDA for the language $L = \{a^n b^{2n} : n \geq 1\}$ and give the configuration of PDA for the string $aabbbb$. (10 Marks)

6. (a) Construct an NPDA corresponding to the grammar $S \rightarrow aA$, $A \rightarrow aABC|bB|a$, $B \rightarrow b$, $C \rightarrow c$. Derive a string for this grammar and show the sequence of moves made by NPDA in processing the same string. (8 Marks)

(b) State and prove pumping lemma for context-free languages. (8 Marks)

(c) Show that the CFL's are not closed under intersection. (4 Marks)

7. (a) Define a Turing Machine. Design a Turing Machine that accepts $L = \{a^n b^n c^n : n \geq 1\}$. (10 Marks)

b. Define non-deterministic TM. show that the class of deterministic Turing Machines and the class of non-deterministic Turing Machines are equivalent. (10 Marks)

8. Write short notes on:

i) Linear Bounded Automata

ii) Chomsky Hierarchy

iii) Post-correspondence problem

iv) Multidimentional Turing Machines. (5×4=20 Marks)

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Reg. No.

Fourth Semester B.E. Degree Examination, January/February 2003

Computer Science/Information Science and Engineering

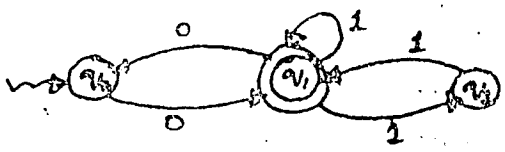
Finite Automata & Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Define a DFA. Construct a DFA which accepts strings of a's and b's with atleast one a. (10 Marks)

   (b) Define an NFA. Convert the following NFA to an equivalent DFA. Minimize it. (10 Marks)



2. (a) Define a regular expression and languages denoted by a regular expression. (4 Marks)

   (b) Let r be a regular expression. Show that there exists some NFA that accepts L(r). (8 Marks)

   (c) Let G=(V,T,S,P) be a right linear grammar, prove that L(G) is a regular language. (8 Marks)

3. (a) Define pumping Lemma for regular languages. Show that the following languages are not regular

   i) $L = \{a^n b^n : n \geq 0\}$ ii) $L = \{a^n b^k c^{n+k} : n \geq o, k \leq 0\}$. (10 Marks)

   (b) Define a CFG. Construct a CFG for the language with $n \geq 0$, $m \geq 0$, $L = \{a^n b^m c^k : k = n + m\}$ Show the left most derivation for an example. (10 Marks)

4. (a) Explain the steps involved in simplification of CFGs. Convert the following grammar into Chomsky normal from

$$S \rightarrow abAB \qquad A \rightarrow bAB/\lambda \qquad B \rightarrow BAa/A/\lambda$$

(12 Marks)

   (b) Define Greibach normal form. Convert the following grammar into GNF

$$S \rightarrow ABa/B \qquad A \rightarrow aA/B/a \qquad B \rightarrow aAb$$

(8 Marks)

5. (a) Define an NPDA. Design an NPDA for the language

   $L = \{a^n b^{n+m} c^m : n \geq 0, m \geq 0\}$ (12 Marks)

Contd.... 2

(b) Construct an NPDA that accepts the language generated by the grammar

$S \rightarrow aSBB \mid aAB \qquad A \rightarrow a \qquad B \rightarrow b.$

Derive a string and show the moves made by the NPDA. (8 Marks)

6. (a) Show that the family of context free languages is closed under union, concatenation and star closure. (10 Marks)

(b) Define a Turing machine. Design a TM which copies a string of I's given. The given string and its copy must be separated by a blank. (10 Marks)

7. (a) Define a universal Turing machine. Show its basic configuration. Explain how is it equivalent to digital computer. (12 Marks)

(b) Define a context sensitive and unrestricted grammar. Discuss about Chomsky hierarchy. (8 Marks)

8. Write detailed note on :

(a) Post correspondence problem

(b) Halting problem

(c) Application of finite automata

(d) Multitape Turing machine. (4×5=20 Marks)

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CS44

MODEL QUESTION PAPER

USN | | | | | | | | | |

Fourth Semester B.E. Degree Examination, February/March 2004

CSE/ISE

Finite Automata and Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Define the terms :

i) alphabet ii) power of an alphabet iii) Strings iv) Languages **(4 Marks)**

(b) Define a DFA and a NFA with examples. **(8 Marks)**

(c) Design a DFA to accept the language

$L = \{W | W$ has both an even number of $O's$ and an even number of 1's $\}$ **(8 Marks)**

2. (a) Define a regular expression. Give a regular expression for the following languages: **(8 Marks)**

i) a string of O's and 1' s with no consecutive O's in it.

ii) a string of O's and 1's ending with 001.

(b) Prove that for every language defined by a regular expression, there exists a finite automata for it. **(8 Marks)**

(c) Write a detailed note on applications of regular expression. **(4 Marks)**

3. (a) State and prove the pumping Lemma of a regular language. **(6 Marks)**

(b) Prove that the following languages are not regular.

i) $\{a^n b^n \mid n \geq 1\}$

ii) $\{a^n b^m \mid n < m\}$ **(6 Marks)**

(c) What is meant by homomorphism ? If L is a regular language over an alphabet $\sum$, and h is a homomorphism on $\sum$, prove that $h(L)$ is regular. **(8 Marks)**

4. (a) Define a context free grammar. Design a context free grammar to accept palindrome over a string of 0' s and 1's. **(8 Marks)**

(b) Define leftmost and rightmost derivations. Give an example for each. **(6 Marks)**

(c) How context freee grammars are used in parsers and markup languages ? **(6 Marks)**

5. (a) With a neat diagram, show the working of a pushdown automata. Define the languages accepted by a PDA. **(12 Marks)**

(b) Design a PDA to accept the languages $L = \{a^i b^j c^k : i + j = k\}$ $i \geq 0, j \geq 0$. **(8 Marks)**

6. (a) With examples, explain the steps to simplify a CFG. **(12 Marks)**

Contd.... 2

(b) Define CNF and GNF. Convert the following grammar into CNF.

$S \longrightarrow ASB/\in \quad A \longrightarrow aAS/a \quad B \longrightarrow SbS \mid A \mid bb$ **(8 Marks)**

7. (a) Define a Turing machine. Design a TM to accept the language $\{a^n b^n C^n \mid n \geq 1\}$. **(12 Marks)**

(b) With diagrams, show the working of multitape and non deterministic turing machines. **(8 Marks)**

8. (a) With a diagram, show how a turing machine can simulate the instruction cycle of a computer. **(12 Marks)**

(b) Write a note on post correspondence problem. **(8 Marks)**

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CSI45

USN

Fourth Semester B.E. Degree Examination, July/August 2004

Computer Science/Information Science and Engineering

Finite Automata & Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Define grammar, proof techniques, language. **(7 Marks)**

(b) Give a simple description of the language generated by the grammar with productions.

$S \rightarrow aA$
$A \rightarrow bs,$
$S \rightarrow \lambda$

(3 Marks)

(c) Design DFA to accept even number of zeros and even number of 1's. **(10 Marks)**

2. (a) Define NFA, DFA and write down differences between them. **(6 Marks)**

(b) Obtain DFA from the following NFA defined by

δ	0	1	2
$\longrightarrow q_0$	$\{q_0, q_1, q_2\}$	$\{q_1 q_2\}$	$\{q_2\}$
q_1	Φ	$\{q_1 q_2\}$	$\{q_2\}$
(q_2)	Φ	Φ	$\{q_2\}$

(8 Marks)

(c) Define regular expression. Construct an NFA for the $L((a+b)^*abb)$ **(6 Marks)**

3. (a) Show that if $\llcorner$ is a regular language on alphabet $\sum$ then there exists a right linear grammar $G = (V, \sum, S, P)$ such that $L = L(G)$. **(8 Marks)**

(b) Find $\frac{L_1}{L_2}$ for $L_1 = L(a^*baa^*)$, $L_2 = L(ab^*)$ **(5 Marks)**

(c) State pumping lemma & show that $L = \{a^P / P$ is a prime $\}$ is not regular using pumping lemma.

[L consists of all strings of a's whose length is a prime] **(7 Marks)**

4. (a) Consider C whose productions are

$S \longrightarrow aAS \mid a$

$A \longrightarrow SbA \mid SS \mid ba$

Show that $S \overset{*}{\Rightarrow} aabbaa$ using LMD & RMD and construct derivation tree whose yield is $aabbaa$. **(5 Marks)**

(b) Define passing with an example. Show ambiguity in context free grammar. **(5 Marks)**

Contd.... 2

(c) Eliminate useless symbols and productions from the following grammar.

$$S \longrightarrow ABa \mid BC$$
$$A \longrightarrow aC \mid BCC$$
$$C \longrightarrow a$$
$$B \longrightarrow bcc$$
$$D \longrightarrow E$$
$$E \longrightarrow d$$
$$F \longrightarrow e$$

(10 Marks)

5. (a) Define CNF and GNF and convert following grammar to CNF.

$$S \longrightarrow abAB$$
$$A \longrightarrow bAB \mid \lambda$$
$$B \longrightarrow BAa \mid A \mid \lambda$$

(12 Marks)

(b) Obtain PDA to accept the language

$L = \{a^n b^{2n} \mid n \geq 1\}$ by final state. (8 Marks)

6. (a) Show that family of CFL is closed under union, concatenation and star closure. (6 Marks)

(b) Show that the language $L = \{a^n b^n c^n \mid n \geq 1\}$ is not a CFL. (7 Marks)

(c) State and prove pumping lemma for CFL. (7 Marks)

7. (a) Define Turing machine. (4 Marks)

(b) Design Turing machine that copies strings of 1's i.e. find a machine that performs the computation

$q_0 w \vdash^* q_f ww$ for any $w \in \{1\}^+$ (8 Marks)

(c) What are multitape and multi dimensional Turing machines? (8 Marks)

8. Write shortnotes on the following:

a) Chomsky hierarchy

b) Unrestricted grammar

c) Post correspondence problem

d) Linear bounded automata (4×5=20 Marks)

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CSI45

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination, January/February 2004

Computer Science/Information Science and Engineering

Finite Automata & Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Define the terms prefix, suffix and sentential form and give one example for each. **(6 Marks)**

(b) Draw deterministic finite automata (DFA) for following languages. $\sum = \{a, b\}$

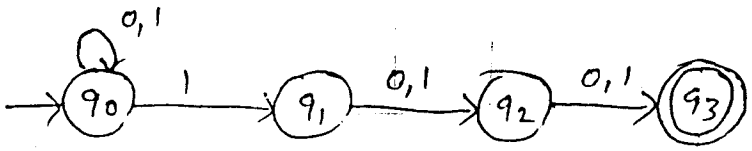
i) $L_1 = \{\omega bab \mid \omega \in \{a, b\}^*\}$

ii) $L_2 = \{\omega(ab + ba) \mid \omega \in \{a, b\}^*\}$ **(8 Marks)**

(c) Describe two applications of automata (DFA) with transition diagrams **(6 Marks)**

2. (a) Define regular expression and give regular expression for $L = \{a^n b^m c^p \mid n \leq 4, m \geq 2, p \leq 2\}$ **(6 Marks)**

(b) Convert the following NFA to DFA.



(8 Marks)

(c) State and prove pumping lemma for regular languages. **(6 Marks)**

3. (a) Discuss the properties of regular languages with examples. **(6 Marks)**

(b) Define right quotient, context - free grammar, derivation tree and S-grammar and give one example for each. **(8 Marks)**

(c) Define ambiguous grammar and show that the grammar. $S \longrightarrow S + S \mid S * S \mid a$ is ambiguous and give an equivalent unambiguous grammar. **(6 Marks)**

4. (a) Describe the procedure to eliminate useless variables and productions and explain with examples. **(6 Marks)**

(b) Eliminate λ, unit, and useless productions $S \longrightarrow a \mid aA \mid B \mid C, A \longrightarrow aB \mid \lambda,\ B \longrightarrow Aa,\ C \longrightarrow cCD,\ D \longrightarrow$ add. **(8 Marks)**

(c) Define Chomsky and Greibach normal forms and convert the following grammar to Chomsky normal form $S \longrightarrow AS \mid AAAS, A \longrightarrow SA \mid aa \mid b$ **(6 Marks)**

5. (a) Define non-deterministic pushdown automata and deterministic pushdown automata. **(6 Marks)**

Contd.... 2

(b) Write a pushdown automata to accept by final state, $L = \{ww^R \mid w \in \{a,b\}^+\}$ and list all transitions. **(8 Marks)**

(c) State pumping lemma for context free languages and show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not a context free language. **(6 Marks)**

6. (a) Show that context free languages are closed under
1) Union ii) Concatenation **(6 Marks)**

(b) Construct NPDA for the grammar
$S \longrightarrow aA, A \longrightarrow aABC \mid bB \mid a, B \longrightarrow b, C \longrightarrow c$ and show that aaabc is accepted by it. **(8 Marks)**

(c) Define Turing machine and explain the various forms of turing machines. **(6 Marks)**

7. (a) Define linear bounded automata, unrestricted grammar and context - sensitive grammar. **(6 Marks)**

(b) Write a turing machine to recognize.

$L = \{a^n b^n \mid n \geq 1\}$ **(8 Marks)**

(c) Write a context - sensitive grammar for

$L = \{a^n b^n c^n\} \mid n \geq 1\}$ and show that $a^3 b^3 c^3$ is generated by that grammar. **(6 Marks)**

8. Write detailed note on :

a) Multitape turing machine

b) Turing thesis

c) Post - corrospondence problem

d) Chemistry Hierarchy **(5×4=20 Marks)**

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NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, January/February 2005

Computer Science and Information Science Engineering

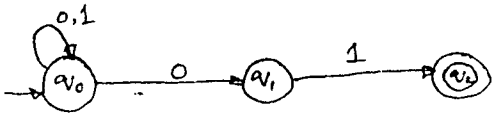
Finite Automata and Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Define a DFA. Construct a DFA to accept a string of 0's and 1's containing two consecutive 0's in it. **(10 Marks)**

   (b) Define an NFA. Convert the following NFA to an equivalent minimized DFA. **(10 Marks)**



2. (a) Define a regular expression. Find regular expression for the following languages on $\{a, b\}$

   a) $L = \{a^{2n}b^{2m};\ n \geq 0, m \geq 0\}$

   b) $L = \{w :| w |\ mod\ 3 = 0\}$ **(10 Marks)**

   (b) Prove that a language is regular if and only if it is accepted by a finite automata. **(10 Marks)**

3. (a) State and prove pumping Lemma for regular languages. Show that the language $L = \{ww^R : w \in \{a, b\}^*\}$ is not regular. **(10 Marks)**

   (b) Explain the table filling method used to minimize the states of a DEA. Find the minimized DFA for the following. **(10 Marks)**

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

Contd.... 2

4. (a) Define a context free grammar. Construct a CFG for the language $L = \{a^n w w^R b^n : w \in \{a, b\}^*\}$ **(10 Marks)**

(b) Define leftmost and rightmost derivations. Give examples. **(6 Marks)**

(c) What is meant by ambiguity ? How to test the ambiguity of a grammar ? **(4 Marks)**

5. (a) Give the formal definition of a PDA. Discuss about the languages accepted by a push down automata. Design an NPDA for the language $L = \{w : a^n b^{2n}\}$ **(12 Marks)**

(b) Construct an NPDA that accepts the language accepted by the grammar $S \longrightarrow 0S1/A \quad A \longrightarrow 1AO/S/\in$ **(8 Marks)**

6. (a) Define Chomsky Normal Form. Simplify the following CFG and convert it to CNF.

$S \longrightarrow ASB \mid \in \quad A \longrightarrow aAS \mid a \quad B \longrightarrow SbS \mid A \mid bb$ **(12 Marks)**

(b) Prove that the family of context free languages are closed under union, concatenation and reversal operations. **(8 Marks)**

7. (a) With a diagram, explain the working of a basic turing machine. Design a turing machine that accepts the language $L = \{0^n 1^n : n > 0\}$ **(10 Marks)**

(b) Explain the general structure of multi-tape and non-deterministic turing machines and show that those are equivalent to basic turing machine. **(10 Marks)**

8. Write detailed note on :

i) Applications of CFGs

ii) Multistack machines

iii) Homomorphism

iv) Post correspondence problem **(5×4=20 Marks)**

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CS44

NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, July/August 2005

Computer Science and Information Science Engineering

Finite Automata and Formal Languages

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Give DFA's accepting the following languages over the alphabet {0,1}

i) The set of all strings ending in 00.

ii) The set of all strings with three consecutive 0's (not necessarily at the end).

(4 Marks)

(b) Write an algorithm to convert any ∈-NFA E to a DFA D such that L(E) = L(D). Prove that the running time of this algorithm is $0(n^3 2^n)$ where n is the number of status in E.

(9 Marks)

(c) Consider the following ∈ -NFA.

	∈	a	b	c
$\rightarrow p$	$\{q,r\}$	Φ	$\{q\}$	$\{r\}$
q	Φ	$\{p\}$	$\{r\}$	$\{p,q\}$
$*r$	Φ	Φ	Φ	Φ

Convert the automaton to a DFA. **(7 Marks)**

2. (a) Convert the following DFA to a regular expression using state-elemination technique. **(7 Marks)**

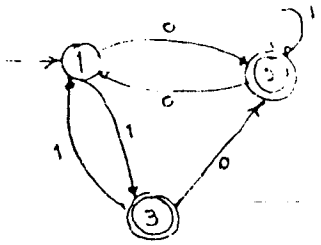

Fig. 2(a)

(b) Prove that the language $L = \{0^{i^2} : i \text{ is an integer, } i \geq 1\}$ is not regular. **(6 Marks)**

(c) Show that if the language L is regular, than $\underline{R}$ is also regular. **(7 Marks)**

3. (a) Prove that if the language L is regular over a alphabet $\sum$, and h is a homomorphism on $\sum$, then h(L) is regular. **(10 Marks)**

(b) Suppose M= $(Q, \sum \delta, q_0, F)$ be a DFA, and we are interested in the language L of all strings $w \in \sum^*$ such that $\hat{\delta}(q_0, w)$ is in F, and also for every state q in Q there is some prefix x_q of w such that $\hat{\delta}(q_0, x_q) = q$. Is L regular? Prove your answer. **(10 Marks)**

Contd.... 2

4. (a) Consider the grammer G=(V,T,P,S) where

$V = \{S\}$

$T = \{(,)\}$

$P = \{S \rightarrow (S)S/E\}$

Prove that the grammer generates all strings of balanced parenthesin, and only such strings. (10 Marks)

(b) Consider the grammer G

$S \rightarrow S + S \mid S * S \mid (S) \mid a$

Show that the string $a + a * a$ has two

i) Parse trees ii) Left most derivations

Find an unambiguous grammer G' equivalent to G and show that L(G) = L(G') and G' is unambiguous. (10 Marks)

5. (a) Design PDA's to accept each of the following languages by final state and by empty stack. (12 Marks)

i) $\{0^n 1^n : n \geq 1\}$

ii) The set of all strings of 0's and 1's with an equal number of 0's and 1's.

(b) Prove that if L is a regular lanaguage, then L=L(P) for some DPDA P. (8 Marks)

6. (a) Let L be a CFL and R be a regular language. Prove that the language $L \cap R$ is a CFL. (12 Marks)

(b) Use part(a) to show that the language $A = \{W : W \in \{a,b,c\}^*$ and contains equal number of $a's, b's$ and $c's\}$ is not a CFL. (8 Marks)

7. (a) Define a turing maching (TM). Design a TM to accept the lanugage $\{0^n, 1^n : n \geq 1\}$ (10 Marks)

(b) Let L be the language accepted by a TM. Prove that L is accepted by a two-stack machine. (10 Marks)

8. (a) Define the following:

i) Recursively enumerable (RE) language.

ii) Recursive language.

iii) Universal language. (6 Marks)

(b) Prove that if L is recursive language then $\overline{L}$ is also recursive language. (6 Marks)

(b) Prove that universal language is RE but not recursive. (8 Marks)

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CS44

NEW SCHEME

Reg. No.

Fourth Semester B.E. Degree Examination, January/February 2006

Computer Science and Information Science Engineering

Finite Automata and Formal Languages

Time: 3 hrs.) (Max.Marks: 100)

Note: *Answer any FIVE full questions.*

1. (a) Prove that the language L is accepted by DFA M iff L is accepted by an $\epsilon - NFA\ N$. (8 Marks)

   (b) Obtain a DFA to accept binary numbers over the alphabet {0, 1} such that they are divisible by 5 and start with 1. For example, 101, 1010, 1111 etc are in the language and 0,0101, 111 etc are not. (6 Marks)

   (c) Obtain a DFA to accept the following language

   $$L = \{w \text{ such that } |w| \bmod 3 \geq |w| \bmod 2 \text{ where } w \in \sum^* \text{ and } \sum = \{a, b\}\}$$ (6 Marks)

2. (a) What is a regular expression? Prove that a language L is accepted by a DFA if and only if L is regular. (8 Marks)

   (b) Give the regular expressions for the following :

   i) strings of a's and b's ending with ab or ba.

   ii) strings of a's and b's such that fourth symbol from the right end is a and fifth symbol from the right end is b.

   iii) strings of a's and b's containing no more than three a's

   iv) strings of a's and b's whose lengths are multiples of 3. (4 Marks)

   (c) Obtain an NFA to accept strings of a's and b's ending with ab or ba. From this NFA obtain an equivalent DFA using subset construction. (8 Marks)

3. (a) State and prove pumping lemma for regular languages. (8 Marks)

   (b) What are distinguishable and indistinguishable states? (2 Marks)

   (c) Minimize the following DFA using table-filling algorithm where A is the start state. "The states C, F and I are final states (10 Marks)

	0	1
A	B	E
B	C	F
*C	D	H
D	E	H
E	F	I
*F	G	B
G	H	B
H	I	C
*I	A	E

Contd 2

4. (a) Obtain the grammar for the languages shown below :

   i) $L = \{a^n b^n c^m d^m \mid n \geq 1,\ m \geq 1\} \cup \{a^n b^m c^m d^n \mid n \geq 1, m \geq 1\}$

   ii) $L = \{w$ such that $\mid w \mid mod\ 3 \neq \mid w \mid mod\ 2$ where $w \in T^*$ and $T = \{a, b\}\}$ (8 Marks)

   (b) Show that the following grammar G is ambiguous. Also obtain the unambiguous grammar G for the following grammar

   $E \rightarrow E + E$
   $E \rightarrow E * E$
   $E \rightarrow E/E$
   $E \rightarrow E - E$
   $E \rightarrow (E) \mid a \mid b.$

   Prove that $L(G) = L(G')$.

   Note : Assume the operators + and - are left associative and * and / as right associative with normal precedence. (12 Marks)

5. (a) Show that for any grammar G, there is a PDA M such that L(G)=L(M). (6 Marks)

   (b) Obtain a PDA to accept the language $L = \{a^n b^n | n \geq 0\}$ by a final state. Give the graphical representation for PDA obtained. Show the moves made by the PDA for the string $aaabbb$. (10 Marks)

   (c) Obtain a PDA equivalent to the following grammar :

   $S \rightarrow aA$
   $A \rightarrow aA|bA|a|b.$ (4 Marks)

6. (a) What are useless symbols? Explain with an example. (4 Marks)

   (b) Eliminate unit productions from the following grammar :

   $S \rightarrow Aa \mid B \mid Ca$
   $B \rightarrow aB \mid b$
   $C \rightarrow Db \mid D$
   $D \rightarrow E \mid d$
   $E \rightarrow ab.$ (6 Marks)

   (c) Prove that if L is regular, then L=L(P) for some DPDA P. (10 Marks)

7. (a) What is a Turing machine and a multi-tape Turing machine? Show that the language accepted by these machines are same. (8 Marks)

   (b) Design a Turing machine to accept the language

   $L = \{a^n b^n c^n \mid n \geq 1\}$

   Give the graphical representation for the Turing machine obtained. (10+2 Marks)

8. (a) Define the following :

   i) Post's correspondence problem
   ii) Recursively enumerable languages
   iii) Recursive language
   iv) Universal language (4×3 Marks)

   (b) Prove that if L is recursive then $\overline{L}$ is also recursive. (8 Marks)

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CSI 45

USN | | | | | | | | | | |

OLD SCHEME

Fourth Semester B.E. Degree Examination, July 2006
CS / IS
Finite Automata and Formal Languages

Time: 3 hrs.] [Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define grammar and language. Explain same with example. **(06 Marks)**

b. Define DFA. Find DFA that accepts all strings on { 0,1 }, except those containing 001. **(08 Marks)**

c. Show that the language $L = \{ awa : W \in \{ a,b\}\}$ is regular. **(06 Marks)**

2 a. Give the procedure to convert NFA to DFA. Convert the NFA shown below to its equivalent DFA.

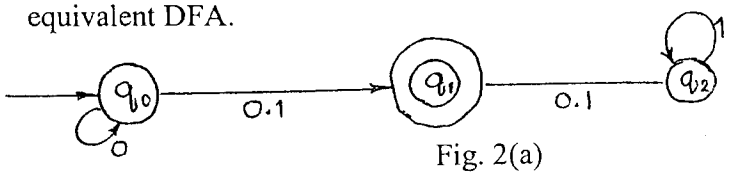

Fig. 2(a) **(10 Marks)**

b. Explain Chomskian hierarchy. **(06 Marks)**

c. Explain with example how you reduce the number of states in finite automata. **(04 Marks)**

3 a. Define regular expression and regular languages. **(06 Marks)**

b. Find the regular expression for the language
$L = \{W \in \{ 0,1 \}^* : W$ has no pair of consecutive zeros$\}$ **(08 Marks)**

c. Find an NFA which accepts L (r) where $r = (a + bb)^* (ba^* + \lambda)$ **(06 Marks)**

4 a. State and explain pumping lemma for regular languages. **(04 Marks)**

b. Show that, $\Sigma = \{ a,b \}$ the language.
$L = \{ W \in \Sigma^* : n_a (w) < n_b (w) \}$ is not regular. **(10 Marks)**

c. Define and explain with example the context free grammars. **(06 Marks)**

5 a. Find the CFG for $L = \{ a^n b^m : n = 2m \}$ with $n,m \geq 0$. **(06 Marks)**

b. Show a derivation tree for the string aabbbb with grammar
$S \rightarrow AB/\lambda$; $A \rightarrow aB$; $B \rightarrow Sb$
Give a verbal description of the language generated by this grammar. **(08 Marks)**

a. Show that the language $L = \{ a^n b^n c^m \} \cup \{ a^n b^m c^m \}$ with n and m being non – negative, is an inherently ambiguous context – free language. **(06 Marks)**

6 b. Convert the grammar with productions
$S \rightarrow ABA$; $A \rightarrow aab$; $B \rightarrow Ac$ to Chomsky normal form. **(06 Marks)**

Contd...2

c. Define and explain with example PDA. (06 Marks)

d. Construct a npda for accepting the language (08 Marks)
$L = \{ WW^R : W \in \{ a,b \}^+ \}$

7 a. Define pumping Lemma for context free language. (06 Marks)

b. Define and explain turing machine. (07 Marks)

c. Design a turing machine that accepts the language denoted by the regular expression OO^* for $\Sigma \{ 0, 1 \}$ (07 Marks)

8 Write short notes on :

a. Ambiguous grammar

b. Multitape turing machine

c. Unrestricted grammar

d. Eliminations of λ - productions. (20 Marks)

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CS44

USN | | | | | | | | | | |

NEW SCHEME

Fourth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
CS / IS
Finite Automata of Formal Language

Time: 3 hrs.] [Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. Mention the differences between DFA, NFA and $\in$ - NFA. (04 Marks)

b. Obtain a DFA to accept the language $L = \{ w \mid w \in (a + b)^* ; N_a(w) \bmod 3 = 2$ and $N_b(w) \bmod 2 = 1 \}$ (08 Marks)

c. Obtain a DFA to accept the following languages
$L = \{ w$ such that $|w| \bmod 3 \neq |w| \bmod 2$ where $w \in \Sigma^*$ and $\Sigma = \{ a, b \}\}$ (08 Marks)

2 a. Prove that there exists a finite automata to accept the language L(R) corresponding to the regular expression R. (06 Marks)

b. Obtain an NFA to accept the language consisting of a's and b's ending with string ab or ba and convert it into equivalent DFA. (08 Marks)

c. Prove that $L = \{ a^{n^2} \mid n \geq 0\}$ is not regular. (06 Marks)

3 a. State and prove pumping lemma for regular languages. (08 Marks)

b. Write the algorithm or the procedure to minimize a DFA using table filling algorithm and use this procedure to minimize the following FA. (12 Marks)

	δ	0	1
→	A	B	F
	B	G	C
	*C	A	C
	D	C	G
	E	H	F
	F	C	G
	G	G	E
	H	G	C

4 a. Obtain the grammar for the languages shown below :

i) $L = \{ a^n b^m c^k \mid n + 2m = k$ for $n \geq 0$ and $m \geq 0 \}$

ii) $L = \{ xy \mid w \in (a + b)^*$ and $y \in (ab$ or $ba) \}$. Show the RMD for the string aabbba along with derivation tree. (12 Marks)

b. Is the following grammar ambiguous?

$E \rightarrow E + E$

$E \rightarrow E * E$

$E \rightarrow E / E$

$E \rightarrow E - E$

$E \rightarrow (E) \mid a \mid b$

If the grammar is ambiguous obtain the unambiguous grammar assuming normal precedence and associativity. (08 Marks)

Contd....

5 a. What is deterministic PDA and non-deterministic PDA? (04 Marks)

b. Obtain a PDA to accept the language $L = \{ W \mid W \in (a + b)^*, N_a(W) = N_b(W) \}$ by a final state. Draw the graphical representation of PDA. Also show the moves made by the PDA for the string abbbaa. (12 Marks)

c. Obtain a PDA equivalent to the following grammar.

$E \rightarrow E + E$
$E \rightarrow E * E$
$E \rightarrow E / E$
$E \rightarrow E - E$
$E \rightarrow (E) \mid a \mid b$ (04 Marks)

6 a. What are useless symbols? Eliminate useless symbols and productions from the following grammar:

$S \rightarrow abA \mid bB$
$A \rightarrow aA \mid d$
$B \rightarrow bB$
$D \rightarrow ab \mid Ea$
$E \rightarrow aC \mid a$ (10 Marks)

b. What is CNF and GNF? Obtain the following grammar in CNF :

$S \rightarrow a\,Ba \mid abba$
$A \rightarrow ab \mid AA$
$B \rightarrow aB \mid a$ (10 Marks)

7 a. Define Turing machine and instantaneous description of TM. (04 Marks)

b. Design a Turing machine to accept $L = \{ WW^R \mid W \in (a + b)^* \}$. Show the sequence of moves made by the Turing machine for the string abba. (16 Marks)

8 Write short notes :

a. Post's correspondence problem.
b. Chomsky hierarchy.
c. Multi-tape Turing machine
d. Inherently ambiguous language. (20 Ma)

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CSI45

USN

OLD SCHEME

Fourth Semester B.E. Degree Examination, July 2007
Computer Science and Engineering
Finite Automata and Formal Languages

Time: 3 hrs.] [Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. Prove that $\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$ by induction. (05 Marks)

b. Define language, grammar, and automata. (05 Marks)

c. Find the grammar for the following:
$L = \{\omega : |\omega| \bmod 3 \neq |\omega| \bmod 2\}$ on $\Sigma = \{a\}$. (05 Marks)

d. Find DFA to generate strings with atleast one 'a' and exactly two b's. (05 Marks)

2 a. Distinguish between NFA and DFA. (04 Marks)

b. Give the formal definition of a regular expression. Find the regular expression for a language consisting of strings over {0, 1} which has at most two zeros. (08 Marks)

c. Let 'r' be a regular expression. Then prove that there exists some NFA that accepts L(r). Find NFA that accepts the language $L(ab^*aa + bbaab)$ (08 Marks)

3 a. Prove that the regular expression: $(a+b)^* = a^*(ba^*)^*$. (05 Marks)

b. What do you mean by homomorphism, homomorphic image. Prove that the family of regular languages is closed under arbitrary homomorphism. (10 Marks)

c. Obtain the right quotient of language L_1 with L_2, where $L_1 = L(a^*baa^*)$, $L_2 = L(ab^*)$. (05 Marks)

4 a. State and prove the pumping lemma for regular languages. (08 Marks)

b. Show that $L = \{a^P : P \text{ is prime}\}$ is not regular using pumping lemma. (06 Marks)

c. Define context free grammar. Find CFG for $L = \{a^n b^m : n \neq 2m\}$. (06 Marks)

5 a. What do you mean by an ambiguous grammar? The grammar G = (V, T, E, P) with V = {E, I}, T = {a, b, c, +, *, (,)} and production E → I, E → E + E, E → E * E, E → (E), and I → a|b|c. Test whether the above grammar is ambiguous. If so resolve the ambiguity. (10 Marks)

b. What do you mean by a useless production? Remove useless productions from the following: S → AB | CA, B → BC | AB, A → a, C → aB | b. (06 Marks)

c. Define Greibach and Chomsky normal forms. (04 Marks)

6 a. Define npda. Construct an npda corresponding to the following grammar:
S → aABB | aAA, A → aBB | a, B → bBB | A. (08 Marks)

b. Show that the language L = {ww: w∈{a, b}*} is not context free using pumping lemma. (06 Marks)

c. Prove that the family of CFGs is closed under intersection and complementation. (06 Marks)

7 a. Define Turing machine. Construct a Turing machine for L {a (a + b}*}. (08 Marks)

b. Given two positive integers x and y. Use unary notation in which any positive integer x is represented by $w(x) \in \{1\}^+$, such that |w(x)| = x. (06 Marks)

c. What is the language accepted by M = ({q_0, q_1, q_2, q_3}, {a, b}, {a, b, □}, δ, q_0, □, {q_3}) with δ(q_0, a) = (q_1, a, R), δ(q_0, b) = (q_2, b, R), δ(q_1, b) = (q_1, b, R), δ(q_0, □) = (q_3, □, R), δ(q_2, b) = (q_2, b, R), δ(q_2, a) = (q_3, a, R). (06 Marks)

8 Write short notes on following:
a) Universal Turing machine b) Nondeterministic Turing machine
c) Linear bounded automata d) The Chomsky hierarchy. (20 Marks)

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CS44

Fourth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Finite Automata and Formal Languages

Time: 3 hrs. Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. Define the following terms:
   i) Alphabets and power of an alphabet
   ii) Language
   iii) DFA, NFA and ϵ - NFA. **(10 Marks)**

b. Construct DFAs that accept the following languages on the alphabet $\Sigma = \{a, b\}$:
   i) All strings with exactly one a
   ii) All strings with atleast one a
   iii) All strings except those which end with 'abb'. **(10 Marks)**

2 a. Convert the following NFA to DFA using 'LAZY' evaluation scheme:

		0	1
Start →	q_0	q_1	ϕ
*	q_1	q_0	q_1, q_2
	q_2	ϕ	q_1

(08 Marks)

b. Let r be a regular expression, show that there exists some NFA that accepts L(r). **(06 Marks)**

c. Obtain the regular expression for the following automata shown in fig.2(c) using state elimination method. **(06 Marks)**

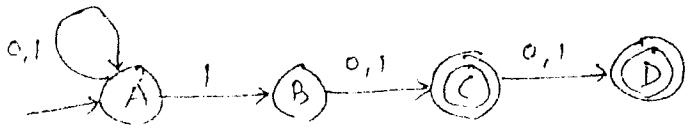

Fig.2(c)

3 a. State pumping lemma and discuss the strategy to apply pumping lemma for regular expression. Prove that the following language is not regular:

$L = \{(ab)^n.a^k : n > k, k >= 0\}$ **(08 Marks)**

b. If L_1 and L_2 are regular languages, then prove that regular languages are closed under difference and reversal. **(04 Marks)**

c. Consider the DFA:

		0	1
→	A	B	A
	B	A	C
	C	D	B
*	D	D	A
	E	D	F
	F	G	E
	G	F	G
	H	G	D

i) Draw the table of distinguishabilities for the DFA.
ii) Construct the minimum state equivalent DFA. **(08 Marks)**

4 a. Define the following terms:
i) Grammar ii) CFG iii) Leftmost derivation iv) Rightmost derivation v) Derivation tree. (05 Marks)

b. What is ambiguous grammar? Prove that the following grammar is ambiguous: (05 Marks)
$S \rightarrow aS|aSbS| \in$

c. Consider the following grammar:
$E \rightarrow +EE|*EE|-EE|x|y$
Find leftmost and rightmost derivations and a derivation tree for the string +*-xyxy. (10 Marks)

5 a. With neat diagram show the working of a pushdown automata and define the language accepted by a pushdown automata. (06 Marks)

b. Design a PDA to accept the language
$L = \{a^n.b^{2n} \mid n>=1\}$
Give the graphical representation for PDA obtained. Show the moves made by the PD for the string aabbbb. (10 Marks)

c. Obtain a PDA equivalent to the following grammar:
$S \rightarrow aA$
$A \rightarrow aA|bA|a|b.$ (04 Marks)

6 a. Find a CFG, without λ productions, unit production and useless productions equivalent to the grammar defined by
$S \rightarrow ABaC$
$A \rightarrow BC$
$B \rightarrow b/\lambda$
$C \rightarrow D/\lambda$
$D \rightarrow d.$ (12 Marks)

b. What are CNF and GNF of context free grammar? Give examples. (04 Marks)

c. Obtain the following CFG in GNF notations:
$S \rightarrow AB$
$A \rightarrow aA|bB|b$
$B \rightarrow b.$ (04 Marks)

7 a. What is turing machine? With neat sketch, explain the working of turing machine. (08 Marks)

b. Design the turing machine for the following language. Write transition diagram and give ID on input aaab. (12 Marks)
$L = \{\omega / |\omega| \text{ is even } \omega \in (a+b)^*\}$

8 Write short notes on the following:
a. Multitape turing machine
b. Application of CFGs
c. Recursively enumerable languages
d. Post's correspondence problem. (20 Marks)

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06CS56

Fifth Semester B.E. Degree Examination, Dec.08/Jan.09

Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions selecting at least Two questions from each part.***

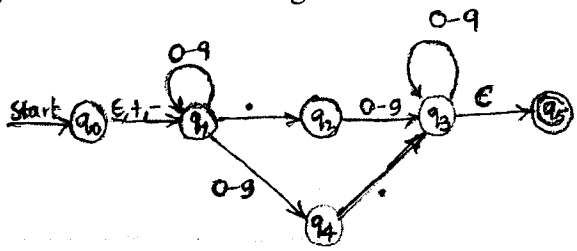
PART - A

1 a. What is Automata? Discuss why study automata. **(06 Marks)**

b. Define DFA and design the DFA for the following languages on $\Sigma = \{a, b\}$.
   i) The set of all strings that either begings or ends or both with substring 'ab'.
   ii) The set of all strings that ends with substring 'abb'.
   iii) $L = \{W : |W| \bmod 5 < > 0\}$ **(08 Marks)**

c. Define ϵ – NFA and design the E – NFA or NFA for the following languages.
   i) abc, abd, and aacd {Assume Σ = a, b, c, d}
   ii) {ab, abc}* {Assume Σ = {a, b, c}. **(06 Marks)**

2 a. Convert the following ϵ I NFA to DFA using "Subset Construction scheme". **(08 Marks)**



b. Define Regular expression and write Regular expression for the following languages.
   i) $L = \{a^{2n} b^{2m+1} : m \geq 0, n \geq 0\}$.
   ii) $L = \{a^n b^m : (m + n) \text{ is even}\}$.
   iii) $L = \{a^n b^m : n >= 4, m <= 3\}$. **(06 Marks)**

c. Prove that every language defined by a Regular expression is also defined by Finite automata. **(06 Marks)**

3 a. If L_1 and L_2 are regular languages then prove that family of regular language are closed under $L_1 - L_2$. **(06 Marks)**

b. State and prove pumping lemma for regular languages. Apply pumping lemma for following languages and prove that it is not Regular $L = \{a^n : n \text{ is prime}\}$. **(08 Marks)**

c. Consider the DFA

δ	0	1
$\rightarrow q_1$	q_2	q_3
q_2	q_3	q_5
* q_3	q_4	q_3
q_4	q_3	q_5
* q_5	q_2	q_5

i) Draw the table of distinguishable and Indistinguishable states for the automata.
ii) Construct minimum state equivalent of automata. **(06 Marks)**

4 a. Define context-free grammer and write context free grammer for the following languages.
i) $L = \{a^i b^j c^k : i + j = k, i >= 0, j >= 0\}$.
ii) $L = \{a^n b^m c^k : n + 2m = k\}$. **(07 Marks)**

b. Consider the grammer.
$E \rightarrow +EE \mid * EE \mid - EE \mid x \mid y$
Find leftmost and rightmost derivation for the string $+ * - xyxy$ and write parse tree. **(08 Marks)**

c. What is ambigous grammer? Prove that the following grammer is ambigous on the string "aab" $S \rightarrow as \mid asbs \mid \in$. **(05 Marks)**

PART - B

5 a. Define PDA and construct a PDA that accepts the following languages.
$L = \{w : w \in (a + b)^*$ and $n_a(w) = n_b(w)\}$. Write the instantaneous description for the string "aababb". **(12 Marks)**

b. For the following grammer construct a PDA.
$S \rightarrow aABB \mid aAA$
$A \rightarrow aBB \mid a$
$B \rightarrow bBB \mid A$
$C \rightarrow a$. **(08 Marks)**

6 a. Consider the grammer.
$S \rightarrow ABC \mid BaB$
$A \rightarrow aA \mid BaC \mid aaa$
$B \rightarrow bBb \mid a \mid D$
$C \rightarrow CA \mid AC$
$D \rightarrow \in$
i) Eliminate t – productions.
ii) Eliminate Unit productions in the resulting grammer.
iii) Eliminate Useless production in the resulting grammer. **(09 Marks)**

b. What is Chomsky normal form? Convert the following grammer b Chomsky normal form.
$S \rightarrow ABa$
$A \rightarrow aab$
$B \rightarrow Ac$. **(05 Marks)**

c. If L_1 and L_2 are context free languages then prove that family of Context–free– languag are closed under Union and concatenation operations. **(06 Marks)**

7 a. Explain with neat diagram, the working of a Turning machine model. **(06 Marks)**

b. Design a Turing Machine to accept all set of palindromes over $\{0, 1\}^*$. Also write its transition diagram and Instantaneous description on the string "1 0 1 0 1". **(14Marks)**

8 Write short notes on following:
i) Post's correspondence problem.
ii) Recursive languages.
iii) Universal Turning Machine.
iv) Pumping lemma for CFL. **(20 Marks)**

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06CS56

Fifth Semester B.E. Degree Examination, June-July 2009
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note : ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Assume missing data if any.

PART - A

1 a. Define i) Powers of an alphabet ii) N F A. **(04 Marks)**

b. Design a DFA to accept the following language over the alphabet { 0, 1}.
i) L = {ω | ω is a even number} ii) L = $\{(01)^i 1^{2j} \mid i \geq 1, j \geq 1\}$
iii) The set of strings either start with 01 or end with 01. **(10 Marks)**

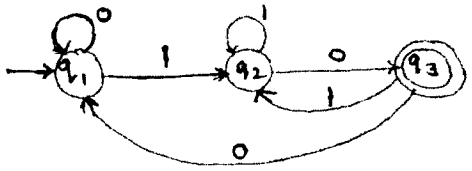
c. Consider the following ε – NFA. **(06 Marks)**

	ε	a	b	c
→ p	ϕ	{p}	{q}	{r}
q	{p}	{q}	{r}	ϕ
* s	{q}	{r}	ϕ	{p}

i) Compute the ε – closure of each state ii) Convert the automation to a DFA.

2 a. Define Regular Expression. Write the regular expression for the following languages:
i) Language of all strings ω such that ω contains exactly one 1 an even number of 0's
ii) Set of strings over {0, 1, 2} containing atleast one 0 and atleast one 1. **(10 Marks)**

b. Convert the following DFA to a regular expression using the state elimination technique. **(06 Marks)**



c. Prove that if R be a regular expression then there exists some ε - NFA that accepts L(R). **(04 Marks)**

a. i) State and prove pumping Lemma for regular languages.
ii) Prove that the following language is not regular : L = $\{0^n 1^{n+1} \mid n > 0\}$.
iii) Prove that if L is a regular language over alphabet Σ - then $\overline{L}$ is also a regular language. **(12 Marks)**

b. Minimize the following DFA using Table filling algorithm. **(08 Marks)**

	0	1
→ A	B	A
B	A	C
C	D	B
* D	D	A
E	D	F
F	G	E
G	F	G

4 a. Construct the CFG for the following Languages
i) $L = \{a^{2n} b^m \mid n \geq 0, m \geq 0\}$ ii) $L = \{ 0^i 1^j 2^k \mid i = j \text{ or } j = k \}$ and Generate left most derivation for the string 0 1 1 2 2. **(10 Marks)**

b. Define Ambiguous Grammar. Prove that the following grammar is Ambiguous. Find an unambiguous grammar. $S \rightarrow a S \mid a S b S \mid \varepsilon$ **(10 Marks)**

PART - B

5 a. Discuss the languages accepted by a PDA. Design a PDA for the language that accepts the strings with $n_a(w) < n_b(w)$ [number of a's less than number of b's]. Where $w \varepsilon (a + b)^*$ and show the instantaneous descriptions of the PDA on input a b b a b. **(14 Marks)**

b. Convert the following grammar to a PDA that accepts the same language by empty stack. $S \rightarrow 0 S 1 \mid A \quad ; \quad A \rightarrow 1 A 0 \mid s \mid \varepsilon$. **(06 Marks)**

6 a. What are Useless Productions? Remove all useless productions, unit productions and all ε – productions from the grammar : **(10 Marks)**

$S \rightarrow a A \mid a B \quad ; \quad A \rightarrow a a A \mid B \mid \varepsilon \quad ; \quad B \rightarrow b \mid b B \quad ; \quad D \rightarrow B$

b. Define CNF. Convert the follwing CFG to CNF.

$S \rightarrow A S B \mid \varepsilon \quad ; \quad A \rightarrow a A S \mid a \quad ; \quad B \rightarrow S b S \mid A \mid b b.$ **(10 Marks)**

7 a. What is Turing Machine and Multi tape Turing Machine? Show that the language accepted by these machines are same. **(08 Marks)**

b. Design a Turing Machine for the language to accept the set of strings with equal number of 0's and 1's and also give the instantaneous description for the input 110100. **(12 Marks)**

8 Write short notes on:
a. Applications of CFG.
b. Homomorphism.
c. Recursive Languages.
d. Post's correspondence problem. **(20 Marks)**

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06CS56

Fifth Semester B.E. Degree Examination, Dec.09/Jan.10
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following terms :
i) Alphabets ii) Strings iii) Power of an alphabet iv) Language. **(06 Marks)**

b. Define DFA. Design a DFA to accept the binary numbers which are divisible by 5. **(06 Marks)**

c. Convert the following NFA to its equivalent DFA using subset construction :

	0	1
→ p	{p, q}	{p}
q	{r}	{r}
r	{s}	ϕ
* s	{s}	{s}

(08 Marks)

2 a. Design an NFA that accepts the language L(aa*(a+b)). **(04 Marks)**

b. Consider the following ∈-NFA :

	∈	a	b	c
→ p	ϕ	{p}	{q}	{r}
q	{p}	{q}	{r}	ϕ
*r	{q}	{r}	ϕ	{p}

i) Compute the ∈-closure of each state.
ii) Give all the strings of length 3 or less accepted by the automation
iii) Convert the automation to a DFA. **(10 Marks)**

c. Write the regular expressions for the following languages :
i) The set of all strings over Σ : {a, b, c} containing atleast one a and atleast one b.
ii) L={w : |w| mod 3 = 0} Assume Σ :{a, b}
iii) The set of strings of 0's and 1's whose 10^{th} symbol from the right end is 1. **(06 Marks)**

3 a. Convert the regular expression $(0 + 1)^*1(0 + 1)$ to an ∈-NFA. **(04 Marks)**

b. State and prove the pumping lemma for regular languages. **(06 Marks)**

c. Consider the transition table Q3(c), of DFA given below :

	0	1
→ A	B	A
B	A	C
C	D	B
* D	D	A
E	D	F
F	G	E
G	F	G
H	G	D

i) Draw the table of distinguishabilities of this automaton
ii) Construct the minimum-state equivalent DFA using table filling algorithm. **(10 Marks)**

4 a. Define CFG. Write CFG for the language $L = \{0^n1^n \mid n \geq 1\}$, i.e. the set of all strings of one or more 0's followed by an equal number of 1's. **(08 Marks)**

b. Consider the grammar –

$S \rightarrow aS \mid aSbS \mid \in$

Is the above grammar ambiguous? Show in particular that the strings aab has two :

i) Parse trees

ii) Leftmost derivation

iii) Rightmost derivations. **(12 Marks)**

PART – B

5 a. Define a PDA. Discuss about the languages accepted by a PDA. Design a nondeterministic PDA for the language $L = \{0^n1^n \mid n \geq 1\}$. **(12 Marks)**

b. Convert the following grammar

$S \rightarrow 0S1 \mid A$

$A \rightarrow \mid A0 \mid S \mid \in$

to a PDA that accepts the same language by empty stack. **(08 Marks)**

6 a. State and prove pumping lemma for context free languages. **(08 Marks)**

b. What are CNF and GNF of context free grammar? Give examples. **(06 Marks)**

c. Using the CFL pumping lemma, show that the following language is not context free.

$L = \{a^i b^j c^k \mid i < j < k\}$. **(06 Marks)**

7 a. With a neat diagram, explain the working of a basic turing machine. Design a turing machine to accept $L = \{ww^R \mid w \in (a + b)^*\}$ **(12 Marks)**

b. Explain the general structure of multi-tape and non deterministic turing machines and show that these are equivalent to basic turing machine. **(08 Marks)**

8 Write short notes on :

a. Recursive languages and holting problem

b. Post's correspondence problem

c. Chomsky hierarchy

d. Applications of CFG's **(20 Marks)**

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06CS56

Fifth Semester B.E. Degree Examination, May/June 2010
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following terms, with an example for each:
i) String ii) Alphabet iii) Powerset iv) Language. **(08 Marks)**

b. Mention the differences between DFA, NFA and ∈-NFA. **(04 Marks)**

c. Convert the following ∈-NFA to DFA. [Refer Fig.Q1(c)]. **(08 Marks)**

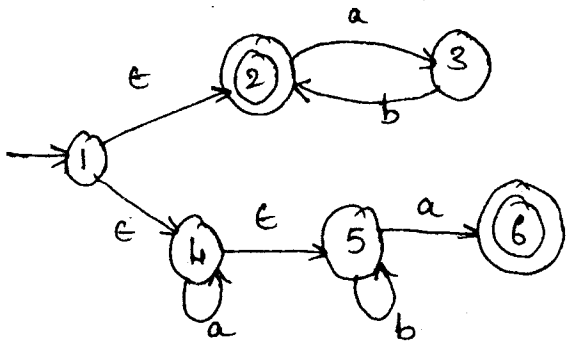

Fig.Q1(c)

2 a. Define a regular expression. Find regular expression for the following languages on {a, b}:
i) $L = \{ a^{2n} b^{2m} : n \geq 0 , m \geq 0 \}$ ii) $L = \{ w : |w| \bmod 3 = 0 \}, w \in \{a, b\}^*$ **(08 Marks)**

b. Prove that if L and M are regular languages, then so is $L \cap M$. **(06 Marks)**

c. Convert the regular expression $(01 + 1)^*$ to an ∈-NFA. **(06 Marks)**

3 a. State pumping lemma for regular languages. Prove that the language $\{a^n b^n \mid n \geq 1\}$ is non-regular. **(10 Marks)**

b. Define distinguishable and indistinguishable states. Minimize the following DFA using table filling algorithm.

f	0	1
→ A	B	F
B	G	C
* C	A	C
D	C	G
E	H	F
F	C	G
G	G	E
H	G	C

(10 Marks)

4 a. Define CFG. Obtain CFG for the following languages:
i) $L = \{ ww^R \mid w \in \{a, b\}^* \}$, w^R is the reversal of w } ii) L = { w : w has a substring ab} **(10 Marks)**

b. What is an ambiguous grammar? Show that the following grammar is ambiguous.
$E \rightarrow E + E \mid E - E \mid E * E \mid E / E \mid (E) \mid a$
where E is the start symbol. Find the unambiguous grammar. **(10 Marks)**

PART – B

5 a. Define PDA. Design PDA to accept the following language by final state.

$L = \{ w \mid w \in \{a, b\}^* , N_a(w) = N_b(w) \}$

Draw the graphical representation of PDA. Also, show the moves made by the PDA for the string abbaba. **(12 Marks)**

b. Convert the following CFG to PDA.

$S \rightarrow aABB \mid aAA$

$A \rightarrow aBB \mid a$

$B \rightarrow bBB \mid A$

$C \rightarrow a$ **(08 Marks)**

6 a. What are useless symbols? Eliminate ϵ, unit and useless productions from the following grammar:

$S \rightarrow Aa\ A \mid CA \mid BaB$

$A \rightarrow aaBa \mid CDA \mid aa \mid DC$

$B \rightarrow bB \mid bAB \mid bb \mid aS$

$C \rightarrow Ca \mid bC \mid D$

$D \rightarrow bD \mid \epsilon$ **(10 Marks)**

b. What is CNF and GNF? Obtain the following grammar in CNF:

$S \rightarrow aBa \mid abba$

$A \rightarrow ab \mid AA$

$B \rightarrow aB \mid a$ **(10 Marks)**

7 a. Prove that the context free languages are closed under union, concatenation and reversal. **(10 Marks)**

b. Design a turning machine that performs the following function:

$q_0 w \vdash^* q_f ww$ for any $w \in \{1\}^*$ **(10 Marks)**

8 Write short notes on:

a. Multitape TM

b. Post correspondence problem

c. Chomsky hierarchy

d. Applications of regular expressions. **(20 Marks)**

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