This question paper contains 7 printed pages] Dec '2017.

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **6508**

Unique Paper Code : **32341502** **HC**

Name of the Paper : **Theory of Computation**

Name of the Course : **B.Sc. (H) Computer Science**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

All questions from Part A are compulsory.

Attempt any *four* questions from Part B.

Assume $\Sigma = \{a\ b\}$ is the underlying alphabet unless mentioned otherwise. Parts of a question must be answered together.

Part A

1. (*a*) Consider the language S*, where S = {aa, b}. How many words does this language have of length 4 ? of length 5 ? of length 6 ? What can be said in general ? 2

P.T.O.

(b) Let S = {ab, bb} and let T = {ab, bb, bbbb}. Show that $S^* = T^*$. 6508 2

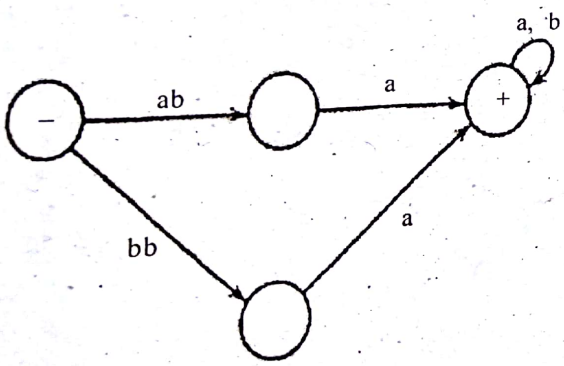
(c) Give a regular expression for the language of all the words that do not have 'aa' as substring. 3

(d) Generate a CFG for b*a*. 3

(e) Design a Deterministic Finite Automata for the language of all the words that end in a double letter. 4

(f) Using Pumping Lemma, prove that language $a^n b^{2n}$, n>=0 is not regular. 4

(g) Convert the following Transition Graph into its equivalent Regular Expression : 4



(h) Show that the complement of a recursive language is also recursive. 4

(i) Construct a Push Down Automata for $a^n b^{n-1}$ where n>=1. 4

(j) If $L_1=(a+b)b(a+b)^*$ and $L_2=(a+b)^*b$, find a Regular Expression and Deterministic Finite Automata for $L_1 \cap L_2$. 5

Part B

2. (a) Begin with the grammar : 5

S → ABC|BaB

A → aA|BaC|aaa

B → bBb|a|D

C → CA|AC

D → ∈.

P.T.O.

(*i*) Eliminate $\in$ productions.

(*ii*) Eliminate any unit productions in the resulting grammar.

(*iii*) Eliminate any useless symbols in the resulting grammar.

(*b*) Using Pumping Lemma, prove that language $a^n b^n a^n$, n>=1 is non-context free. 5

3. (*a*) Prove that the regular languages are closed under complement. 3

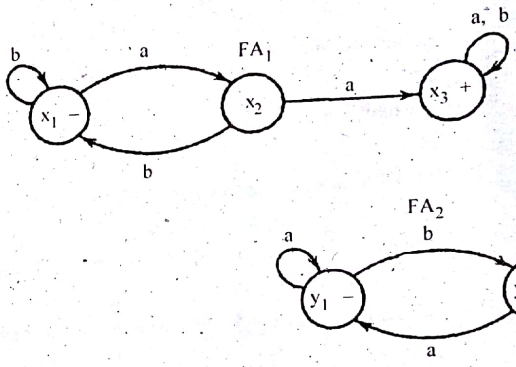
(*b*) Give a CFG for the langauge of all the words having **'bbb'** as substring. 3

(*c*) Show that the following grammar is ambiguous : 4

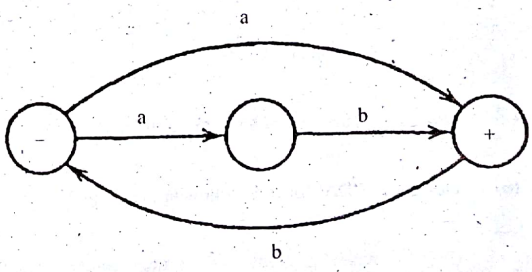
$S \rightarrow XbaaX|aX$

$X \rightarrow Xa|Xb|\wedge$.

4. (*a*) Find FA_1FA_2(concatenation) for the following automata : 5



(*b*) Find the equivalent Deterministic Finite Automata for the following Non-deterministic Finite Automata : 5



5. (*a*) Describe the language for the following regular expressions : 4

(*i*) **(a+b)* ab(a+b)***

(*ii*) **((a+b)b)*.**

(*b*) Build a DFA that accepts all words with fewer than four letters. 3

(*c*) Give a regular expression for the language of all the words that do not have a double letter. 3

6. (*a*) Explain halting problem. 2

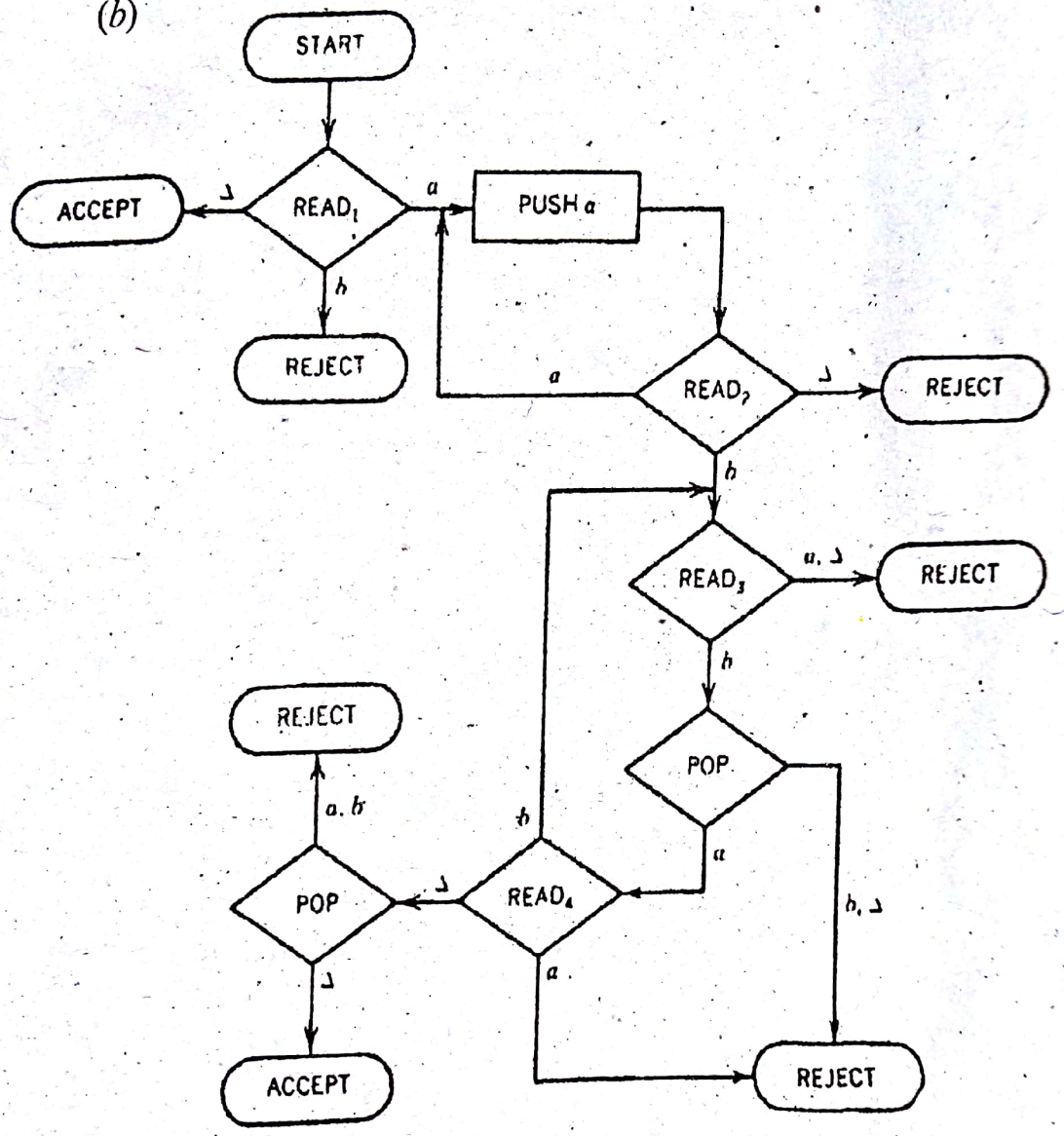
(*b*) Show that if language L is recursive, then L is recursively enumerable also. 3

(*c*) Design a Turing Machine for $a^n b^n$ for n>=1. 5

7. (*a*) Design a PDA for the following language : 5

$L=\{a^n S$, where S starts with b and length(S)=n$\}$.

(b)



(*i*) Define the language defined by above PDA. 2

(*ii*) Trace the word '**abb**' on the above PDA. 3

E.R.-dd course - Dec 2017.

This question paper contains 4+1 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5638**

Unique Paper Code : **234501** **H**

Name of the Paper : **Theory of Computation (CSHT-511)**

Name of the Course : **B.Sc. (H) Computer Science**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** (Section A) is compulsory.

Attempt any *four* questions from Section B.

Parts of a question must be answered together.

Assume $\sum = \{a, b\}$ for all the questions, unless specified otherwise.

Section A

1. (*a*) Let S = {ab, bb} and let T = {ab, bb, bbb}. Show that $S^* \neq T^*$, but that $S^* \subset T^*$. 2

(*b*) Build Deterministic Finite Automata for the languages of all the words that do not end with *ba*. 3

P.T.O.

Dec 2017 (F.R)

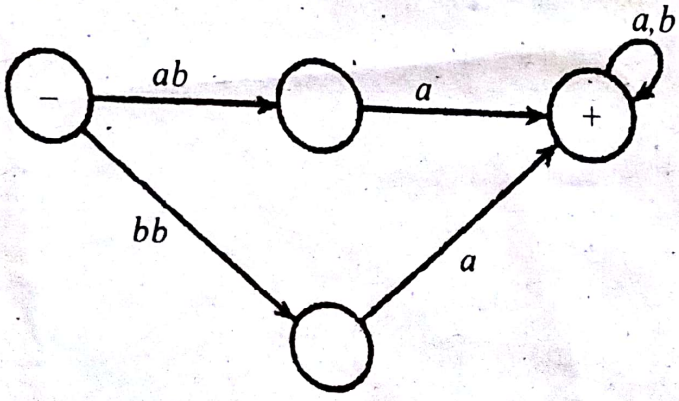
(c) Give regular expression for the languages of all the words that do not have the substring *ab*. 3

(d) Describe briefly the halting problem of Turing machines. 3

(e) Convert the following Grammar into Greibach Normal Form. 3

$S \rightarrow abSb|aa.$

(f) Using Bypass algorithm, convert the following Transition Graph into regular expression : 4



(g) Prove that $a^n b^m a^n$ for $m,n >= 1$ is not a regular language. 4

Dec 2017 (E.R.)

(*h*) Find CFG for the language $a^n b^{n+1}$ where n> = 0. 4

(*i*) Design a PDA for the following language : 4

L = {a^nS, where S starts with b and Length(S) = n.

(*j*) For L_1 and L_2, systematically find the regular expression and a deterministic finite automation that define $L_1 \cap L_2$: 5

L_1 = (a + b) b(a + b)*

L_2 = (a + b)*b.

Section B

2. (*a*) Prove that the regular languages are closed under union and Kleene closure. 4

(*b*) Build Deterministic Finite Automata for the languages of all the strings of length four or more such that the next-to-last letter is equal to the second letter of the input string. 6

Dec 2017 (E-R)

3. (*a*) Prove if the following language is ambiguous or not : 3

$S \rightarrow XbaaX \mid aX$

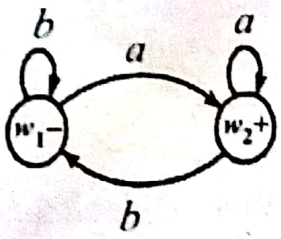
$X \rightarrow aX|bX| \Lambda$

(*b*) Construct a PDA for the language $a^n b^{2n}$, where $n >= 0$. 4

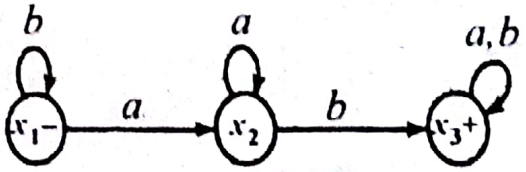
(*c*) For the above PDA trace the PDA for input aabb. 3

4. (*a*) Construct finite automata $FA_1 + FA_2$, where FA_1 and FA_2 are given below : 5

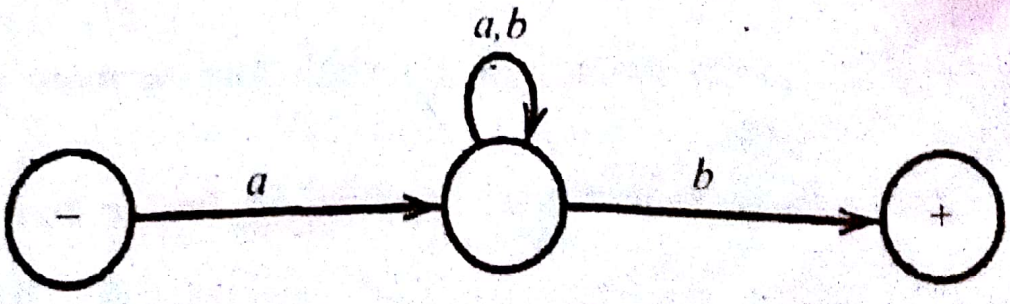
FA_1



FA_2



(*b*) Convert the following NFA into its equivalent DFA : 5



DEC 2017 (E.R.)

5. (*a*) Prove that the recursive languages are also recursively enumerable. 4

(*b*) Build a Turing Machine for $a^n b^n c^n$, where $n>=1$. 6

6. (*a*) Prove that the language $a^n b^n a^n$ for $n>=1$, is not context-free. 5

(*b*) Find a CFG for the following language : 5

TRAILING-COUNT = $\{sa^{length(s)}$ for all s in $(a+b)^*\}$.

7. (*a*) Prove that if a language L is recursive, then its complement of L is also recursive. 4

(*b*) Transform the grammar $S \rightarrow aSaA|A, A \rightarrow abA|b$ into Chomsky Normal Form. 3

(*c*) Explain Church Turing Thesis. 3

Nov. 2016 (E.R).

This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper	: **1332**
Unique Paper Code	: **2341502**
Name of Paper	: **Theory of Computation**
Name of Course	: **B.Tech. Computer Science**
Semester	: **V**
Duration :	: **3 hours**
Maximum Marks	: **75**

F–7

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. 1 is of 35 marks and all its parts are compulsory.
Attempt four questions from Q. Nos 2 to 7.

PART A

Note: For all the questions, consider the alphabet {a,b} unless otherwise specified.

1. (a) Is $(S^*)^+ = (S^+)^*$ for all sets S ? Explain with an example. (2)

   (b) Consider the language PALINDROME and a string y over the given alphabet. Prove that if the string y^3 is in PALINDROME, then so is the string y. (3)

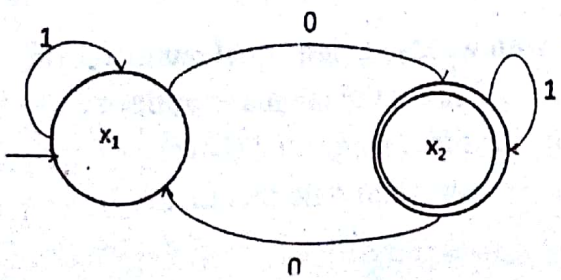
   (c) Give a regular expression for the language of all words that do not end in a double letter. (3)

   (d) Show that (ab)*a and a(ba)* define the same language. Give the set of strings representing the two languages. Give the first five strings generated in the lexicographic manner. (2)

   (e) Using pumping lemma for regular languages, show that the language $L=\{a^nba^n \mid n \geq 0\}$ is not regular. (3)

   (f) Given two Finite Automata(FA): FA_1 and FA_2. find the machine for the intersection of the languages represented by these FA's. (4)

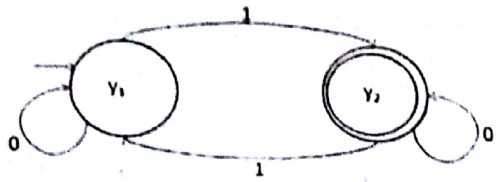
   FA_1



P.T.O.

NOV 2016 (E.R)

FA$_2$



(g) Create a Push Down Automata(PDA) for the language L = { a^nS , where S starts with b and length (S) = n }. (4)

(h) Find a Context Free Grammar(CFG) for the language defined by the regular expression a*b*. (2)

(i) Show that the following CFG is ambiguous by finding a word with two distinct syntax trees: (3)

S→AA

A→AAA| a | bA | Ab

(j) Convert the following CFG into CNF: (3)

S→aXX

X→aS | bS | a.

(k) Explain the working of the following Turing Machine(TM) (2)

$$>R \xrightarrow{a \neq U} R \xrightarrow{b \neq U} R_U a R_U b$$

U represents the blank symbol.

(l) Describe the Universal Turing Machine. (4)

PART B

2(a) Let language L_1= EQUAL, the language with words having equal number of a's and b's and L_2= $\{a^nb^ma^n \mid m,n=1,2,...\}$. What is the language defined by the intersection of L1 and L2? Is it a context free language? If yes, construct a PDA for the language, else prove using pumping lemma for CFLs. (6)

NOV 2016 (E. R.)

2(b) Construct a CFG for the language $L = \{ a^m b^n \mid m>n, m, n>=1 \}$. (4)

3(a) Prove that regular languages are closed under complementation, i.e., if a language L is regular then L'(complement of L) is also regular. (3)

3 (b) For the following pair of regular languages find an FA that defines the difference, L_1-L_2: (4)

$L_1 = (a+b)^* c$

$L_2 = b(a+b)^* c$

$\Sigma = \{a,b,c\}$

3 (c) Build an FA that accepts the language of all strings of a's and b's such that the next to last letter is an a. (3)

4(a) Consider the homomorphism h from the alphabet {0,1,2} to {a,b}.defined by: (4)

h(0)=ab, h(1)=b, h(2)=aa

i) What is h(0210)?

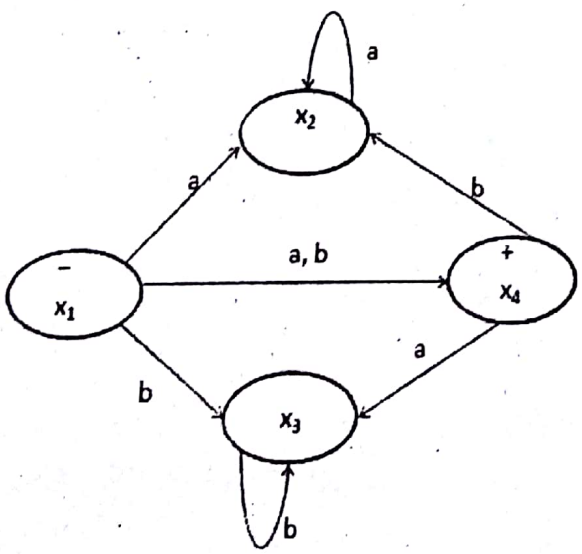
ii) What is h(2201)?

iii) If L is the language 1^*02^*, what is h(L)?

4(b) Give a PDA for the language with words of type $a^x b^y a^z b^w$ x,y,z,w = 1, 2,3 ... (6)

y>x and z>w and x+z=y+w.

5(a) Convert the following NFA to DFA. (5)



5 (b) Write regular expression and construct a DFA for the following language of all words that have an even number of substrings **ab** in them. (5)

P.T.O.

Nov 2016 (ER:)

6(a) Consider the following CFG in Chomsky Normal Form (CNF) (6)

S→PQ

Q→QS | b

P→a

Generate the derivation trees for the word i)abab ii)abababab

Consider S as the self embedded non terminal, trace the division of each word *w* into uvxyz and uvvxyyz,

where $|u|+|z|>=0$, $|v|+|y|>0$ and $|x|>0$.

6(b) Which of the following could be configurations of a Turing Machine? (4)
Justify your answer.

i. (q, ►aUaU, U, Ua)
ii. (q, abc, b, abc)
iii. (p, ►abc, a, e)
iv. (h, ►, e, e)

(► *represents the left end symbol*)

7 (a) Give a Turing Machine which computes the function f(w) =ww. (5)

7 (b) The language H = { "M""w" : Turing machine M halts on input w} (5)
describes the halting problem. Prove that H is not recursive, i.e., the Halting problem is undecidable.

This question paper contains 3 printed pages. *Your Roll No. .....*

F-5

Dec 2015

Sl. No. of Ques. Paper	: 6192
Unique Paper Code	: 2341502
Name of Paper	: Theory of Computation
Name of Course	: B.Tech. Computer Science
Semester	: V
Duration :	: 3 hours
Maximum Marks	: 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. 1 is of 35 marks and all its parts are compulsory Attempt any four questions from Q. No. 2 to Q. No. 7.

PART A

NOTE: *For all the questions, consider the alphabet {a, b} unless otherwise specified.*

1. (a) For a language defined over the alphabet , is $(a^*b^*)^*=(a+b)^*$? Generate the first 6 words of each of the language in the lexicographic order. 3

(b) Construct a Finite Automata (FA) for a language having strings that do not end in a double letter, *i.e.*, aa or bb. 3

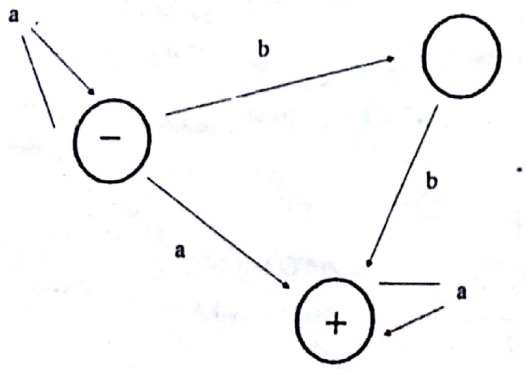
(c) Build an FA machine that accepts all strings that have an even length that is not divisible by 6. 3

(d) Consider the grammar for the language a^nb^n:

$$S \rightarrow aS|ab$$

Chomky-ize the grammar. 3

(e) Convert the following Non-deterministic FA (NFA) to Deterministic FA (DFA): 3



(f) Find a Context Free Grammar (CFG) for a language of the form $a^xb^ya^z$ where x, y, z = 1, 2, 3 ... and x + z = y = {abba, aabbba, abbbaaa, ...} 4

P. T. O.

(g) Construct a Push Down Automata (PDA) that accepts strings with unbalanced open and close round braces, where all the opening braces precede the closing braces, *i.e.*, strings of the form $(^n)^m$, where n, m = 1, 2, 3 ... (*i.e.*, n, m ∈ N) and n≠m. Some example strings are {(), ((), (((), ((((, ... }. The alphabet for the language is {(,)}. 4

(h) Design a Turing Machine (TM) to accept the language with words of the form $a^nb^na^n$ where n = 1, 2, 3 ... (*i.e.*, n, m ∈ N). 4

(i) Construct a TM that transforms the configuration U*w*U (where *w* is an input string with no blanks) into the configuration UU*w*U. U is representing the blank symbol and _ shows the current position of the head of the TM. 4

(j) Use Pumping Lemma to show that the language PALINDROME is non-regular. 4

PART B

2. (a) What language is PALINDROME ∩ $\{a^nb^{n+m}a^m \mid n, m = 1, 2, 3 \ldots$ (*i.e.*, n, m ∈ N)}. Is it context free? If context free, draw the PDA, else use Pumping Lemma to show that it is non-CF. 5

(b) Give a CFG for language with words of type $a^xb^ya^zb^w$, x, y, z, w = 1, 2, 3 ... y > x, z > w and $x+z = y+w$. 5

3. (a) Consider the CFG in Chomsky Normal Form (CNF):

$S \rightarrow PQ$

$Q \rightarrow QS/b$

$P \rightarrow a$

5

Generate the derivation trees for the words (i) abab, (ii) abababab.

Consider Q as the self embedded non terminal, trace the division of each word w into uvxyz and uvvxyyz, where |u| + |z| ≥ 0, |v| + |y| > 0 and |x| > 0.

(b) Consider the following languages:

$L_1 = \{a^nb^m$ where $n \geq m\}$

$L_2 = \{a^nb^m$ where $m \geq n\}$

What is the language formed by their intersection? Show that this language is context free by constructing a PDA. 5

(a) Use pumping lemma to show that language $\{a^nb^{2n} \mid n = 1, 2, 3 \ldots\}$ is non-regular. 4

(b) For the languages $L_1 = (a+b)^*a$ and $L_2 = (a+b)^*aa(a+b)^*$ construct the respective FAs and derive the finite automata that define $L_1 \cap L_2$. 1+2+3

5. (a) Consider the homomorphism h from the alphabet {0, 1, 2} to {a, b} defined by:

$$h(0) = ab,\ h(1) = b,\ h(2) = aa.$$

(i) If L is the language $(ab + baa)^*bab$, what is $h^{-1}(L)$?

(ii) If L is the language consisting of the single string ababb, what is $h^{-1}(L)$? 4

(b) Given the language represented by $(1+0)^*1$, show that the reverse of the language is also regular using a DFA. 3

(c) Construct a DFA accepting all strings w over {0, 1} such that the number of 1's in w is 3 mod 4. 3

6. (a) Give the regular expression for the following language:

(i) All the strings in which b's occur in clumps of an odd number at a time such as abaabbbab, ab, ababbba , ...

(ii) All words that contain exactly two b's or exactly three b's. 3+2

(b) If L is a recursive language, then prove that its complement is also recursive. 5

7. (a) What does the following notation represent:

U("M""w") = "M(w)", where $M = (K, \Sigma, \delta, s, H)$ and U is the Universal TM. 5

(b) Design a Turing Machine for finding the two's complement of a given number which is provided as input to it in binary form over the alphabet {0, 1}. 5

Dec 2014.

This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 831

Unique Paper Code : 234501 E

Name of the Paper : Theory of Computation (CSHT-511)

Name of the Course : B.Sc. (Hons.) Computer Science

Semester : V

Duration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. 1 (Section A) is compulsory. Attempt any 4 questions from Section B. Parts of a question should be attempted together.

Assume $\Sigma = \{a, b\}$ for all the questions unless specified otherwise.

Section A

1. (*a*) Consider the language S*, where S = {*a*, *b*}. How many words does this language have of length 2 ? of length 3 ? of length *n* ?. 2

(*b*) Write the regular expression for all strings of length 6 or less. 2

(*c*) Consider the CFG 2

$S \ldots \rightarrow Xbaa X \mid aX$

$X \ldots \rightarrow Xa \mid Xb \mid \wedge$

Describe the language this CFG generates.

P.T.O.

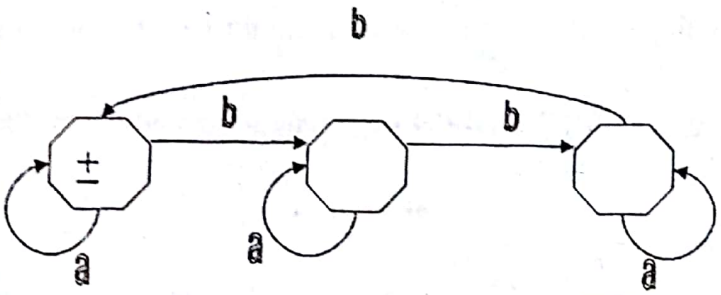
(*d*) Show that the following pair of regular expression define the same language over alphabet set : 2

$$(a + b)^* \text{ and } (a^* + b)^*.$$

(*e*) Build a deterministic finite Automata over $\Sigma = \{0, 1\}$ that accept the binary strings divisible by : 3

3 {11, 110, 1001, 1100, ...}.

(*f*) Describe the language for the given finite automata : 3



(*g*) Using pumping Lemma, show that language :

$$\{a^n\ b\ a^n \text{ where } n = 0, 1, 2 .....\}$$

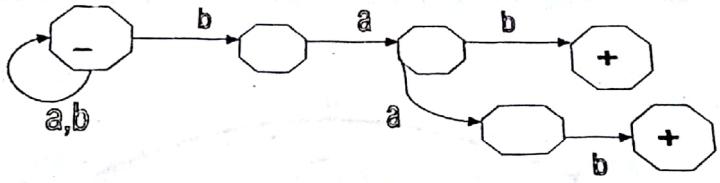
is non-regular. 4

(*h*) Describe the function of the following turing machine : 4

$$> R \xrightarrow{a \neq U} R \xrightarrow{b \neq U} R_U a R_U b$$

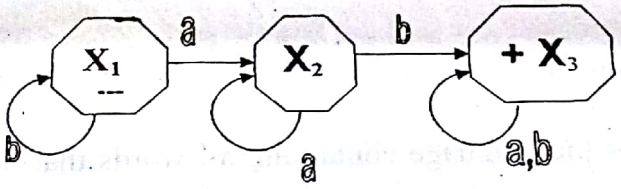
Dec 2014

(*i*) Using Bypass algorithm, convert the following transition graph into regular expression : 4

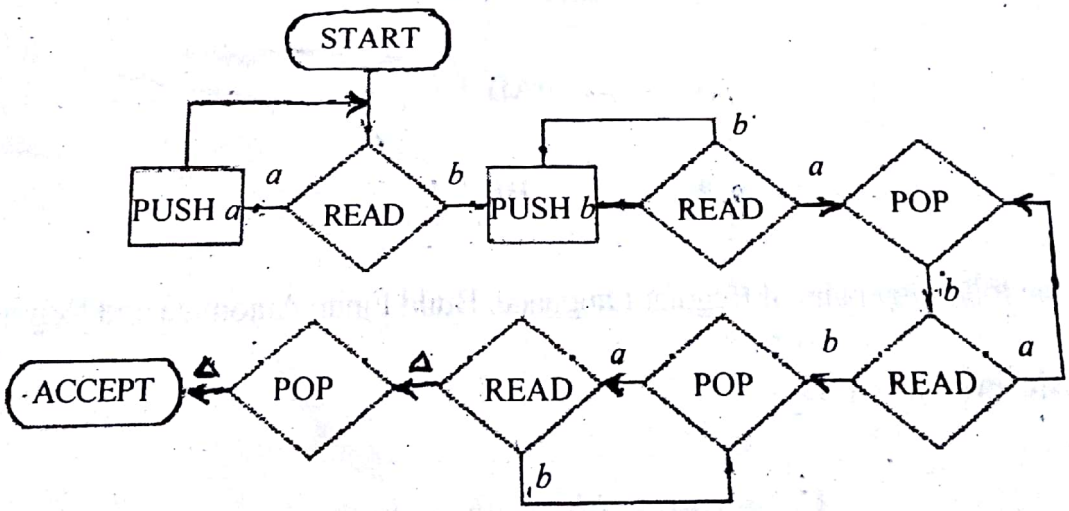


(*j*) Given Finite Automata Machine FA. Using Kleene's theorem algorithm, find (FA FA) 4

FA:



(*k*) Given a PDA : 2+3=5



(*i*) What is the language accepted by the PDA.

(*ii*) Trace the string *aababb* for this PDA.

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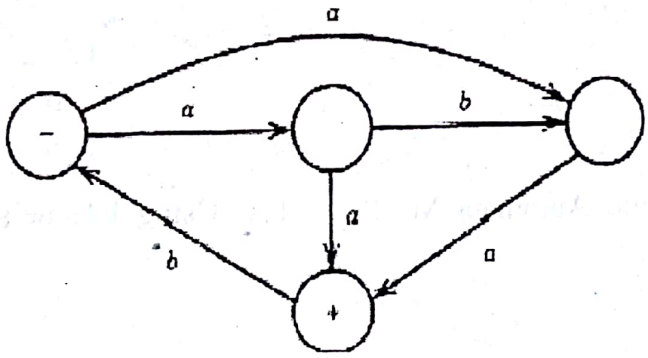
Section B

2. (*a*) Convert the following Non-deterministic Finite Automata to Deterministic Finite Automata. 5



(*b*) Build deterministic finite automata for a regular expression $(bb + bba)^* a$. 5

3. (*a*) Find CFG for the language containing all words that does not contain *aa*. 5

(*b*) Show that the following CFG is ambiguous : 5

$$S \ldots \rightarrow aB \mid ab$$

$$S \ldots \rightarrow aAB \mid a$$

$$B \ldots \rightarrow ABb \mid b$$

4. (*a*) For the following pairs of Regular Language, Build Finite Automata and Regular Expression that define $L_1 \cap L_2$. 4+2=6

$$L_1 = (aa + bb + ab + ba)^*$$

$$L_2 = (a + b)^* aa (a + b)^*$$

Dec 2014

(b) Prove that the language : 4

$$\{a^n\ b^n\ a^n\ b^n \text{ where } n = 1, 2, 3, 4, ...\}$$

is non-context free.

5. (a) Consider the turing machine M : 5

$$M = (K\ \Sigma, \delta, s, \{h\})$$

where :

$$K = \{q_0, q_1, h\},$$

$$\Sigma = \{a_1\ U, \triangleright\},$$

$$s = q_0$$

And δ is given by the following table :

q	σ	$\delta(q, \sigma)$
q_0	a	(q_1, U)
q_0	U	(h, U)
q_0	$\triangleright$	$(q_0, \rightarrow)$
q_1	a	(q_0, a)
q_1	U	$(q_0, \rightarrow)$
q_1	$\triangleright$	$(q_1, \rightarrow)$

Trace the computation of M starting from the configuration $(q_0, \triangleright \underline{U} aaaa)$.

P.T.O.

Dec 2014

(*b*) Build a PDA for the language : 5

$$L = (a^n\ b^{2n} \text{ where } n = 0, 1, 2, \ldots \}$$

6. (*a*) Give a turing machine that computes the following function from strings in : 4

$$\{a, b\}^* : f(w) = ww^R \ (f(abb) = abbbba)$$

(*b*) Prove that a language is recursive if and only if, it and its complement both are recursively enumerable.

7. (*a*) Convert the following grammar into CNF : 3

$S -> ABa$

$A -> aab$

$B -> Ac$

(*b*) Given L_1 = Palindrome language and L_2 = language of $a^+\ b^+\ a^+$. Find $L_1 \cap L_2$. 3

(*c*) Prove that if L_1 and L_2 are regular languages then $L_1 + L_2$, $L_1\ L_2$ are also regular languages. 4

Nov, 2013

This question paper contains 4+2 printed pages]

Roll No. | 1 | 1 | 0 | 0 | 3 | 2 | 7 | 0 | 0 | 0 | 9 |

S. No. of Question Paper : **6075**

Unique Paper Code : **234501** **D**

Name of the Paper : **Theory of Computation (CSHT-511)**

Name of the Course : **B.Sc. (Hons.) Computer Science**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** (Section A) is compulsory.

Attempt any *four* questions from Section B.

Parts of a question should be attempted together.

Assume $\Sigma = \{a, b\}$ for all the questions unless specified otherwise.

Section A

1. (*a*) Is for all sets $(S^+)^* = (S^*)^+$? 2

(*b*) Generate a CFG for a^*b^*. 2

(*c*) Give Regular expression for all words that do not end in a double letter. 2

P.T.O.

(d) Define Deterministic Finite Automata. 2

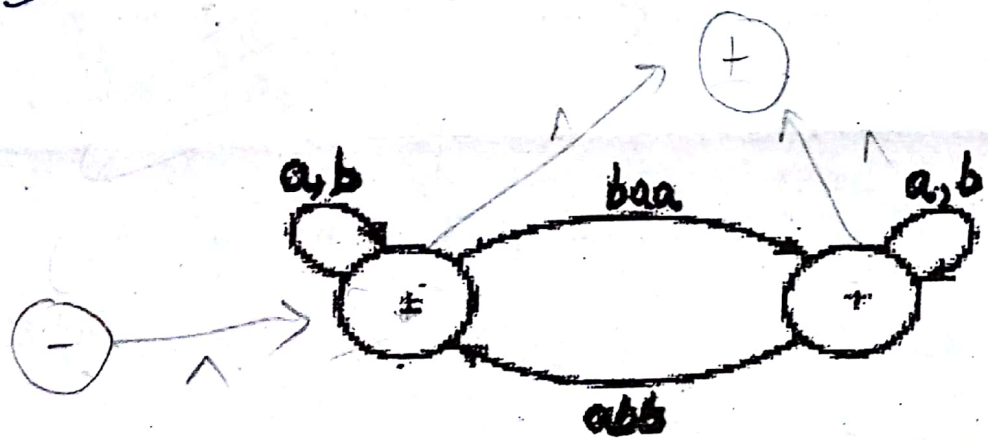
(e) Design a Deterministic Finite Automata for all strings that either starts with ab or ends with ba. 3

(f) Give the full details of the following Turing Machines : 3

>L → L L2

>L L and > L → R

(g) Convert the following Transition graph into Regular Expression. 4



(h) Convert the following CFG into CNF : 4

$$S \rightarrow bA \mid aB$$

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

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

a - 2
b - 2
c - 2
d - 2
e - 3
f - 3
g + 4
h - 4

i - 4
j - 4
k - 5

(i) Show that the language $L = \{a^n\ b\ a^{n+1}$ where $n = 1\ 2\ 3....\}$ is non-regular. 4

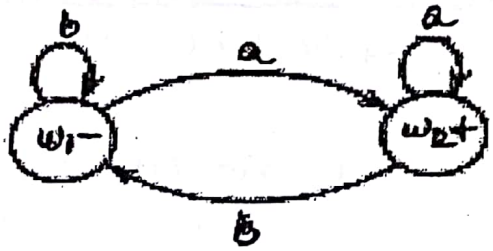
(j) Construct a DFA for the language where every 00 is followed by 1 over alphabet set {0, 1}. 4

(k) Construct PDA : 5

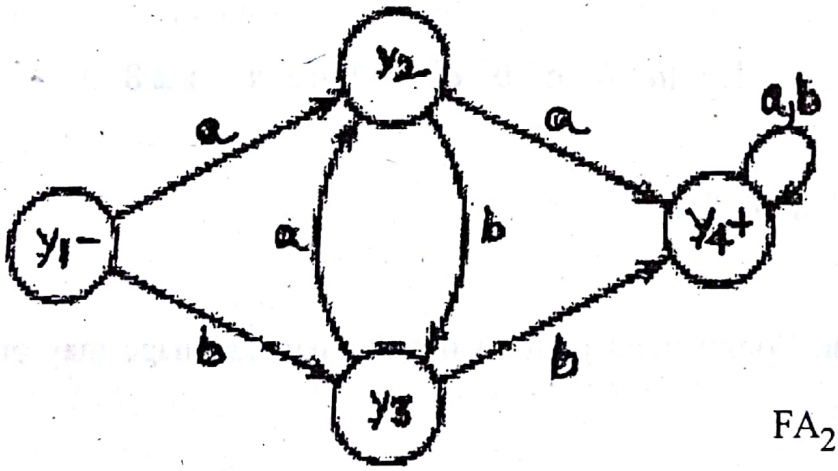
$$L = \{a^n\ b^n\ c^{n+m} : n >= 0, m >= 0\}.$$

Section B

2. (a) Find the Union Machine for the given FA_1 and FA_2. 5



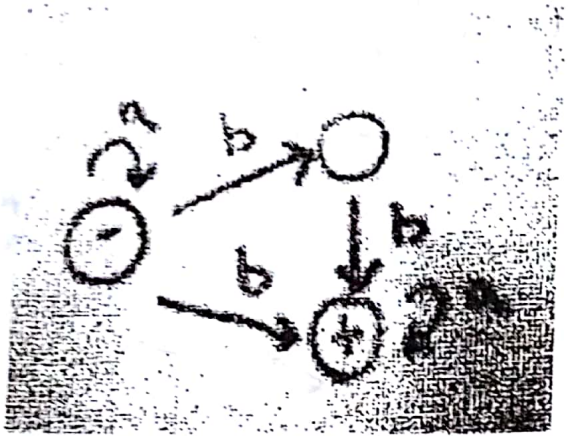
FA_1



FA_2

P.T.O.

(b) Convert the given NFA into DFA. 5



3. (a) Build a DFA and give Regular Expression that define $L_1 \cap L_2$ where :

$$L_1 : (a+b)\, b\, (a+b)^*$$

$$L_2 : b\, (a+b)^*.$$ 6

(b) Show that the language :

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

is non Context Free. 4

4. (a) Show the Complement of the Context Free Language may or may not be Context Free. 5

(*b*) Show that the CFG is ambiguous :

$$S \rightarrow XaX$$

$$X \rightarrow aX \mid bX \mid \wedge .$$ 5

5. (*a*) Explain the Concept of Random Access Turing Machine. 2

(*b*) Explain Halting Problem. 2

(*c*) Give PDA for the language :

$$L = \{a^n\ b^{2n} \quad \text{where } n = 1\ 2\ 3....\}.$$ 6

6. (*a*) Show that if L is recursive, then L is also recursively enumerable. 4

(*b*) Design a Turing Machine which gives two's complement of a given input in binary form on the input tape. 6

7. (*a*) Describe the Language for the following Regular Expressions : 3

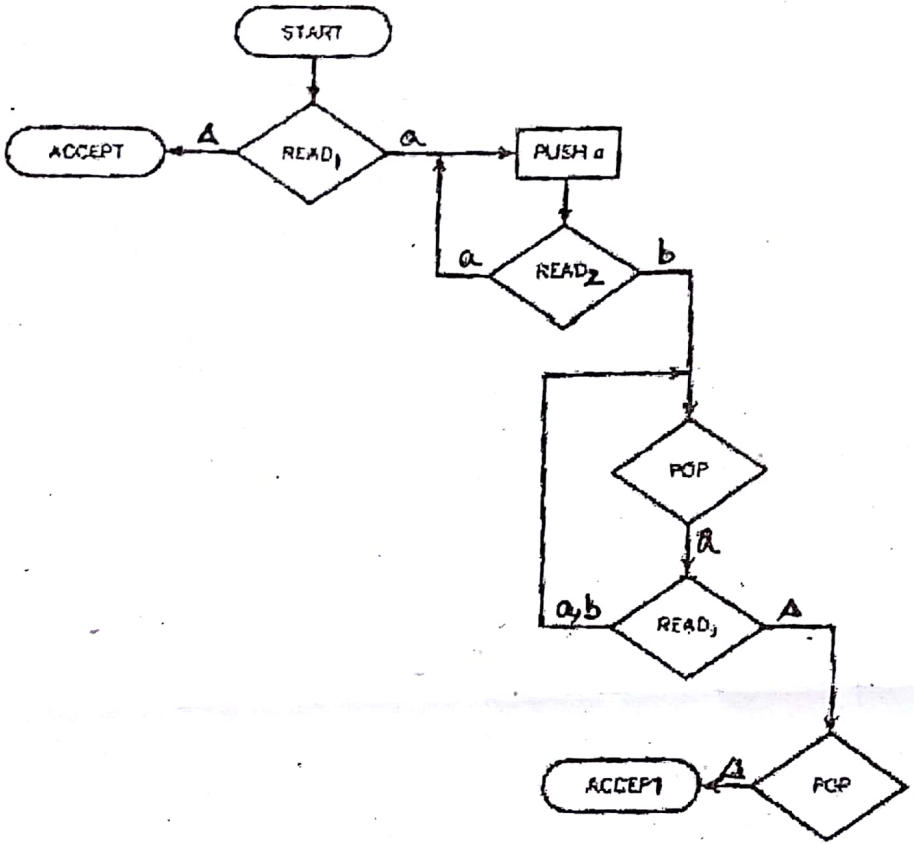
(*i*) $(a+b)^* ab(a+b)^*$

(*ii*) $(a(a+bb)^*)^*$

(*b*) Build a DFA that accepts all words with exactly four letters. 3

P.T.O.

(c) Trace the following PDA for the given string sequence *aaaabb*. 4



This question paper contains 7 printed pages] May '2013

Your Roll No. .....

N 1055 14477 28

C

B.Sc. (H) Computer Science/VI Sem.

Paper 601 : THEORY OF COMPUTATION

(Admissions of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** (Section A) is compulsory.

Attempt any *four* questions from Section B.

Parts of a question should be attempted together.

Assume $\Sigma = \{a, b\}$ for all the questions unless specified otherwise.

Section A

1. (*a*) Let S = {ab, bb} and T = {ab, bb, bbbb}. 2

Show that :

$S^* = T^*$.

(*b*) Define deterministic finite automata. 2

P.T.O.

(*e*) Consider the CFG : 2

$S \rightarrow XaXaX$

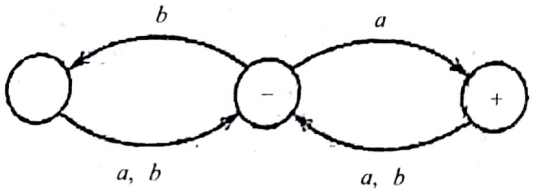
$X \rightarrow bX|aX|\wedge$

Describe the language this CFG generates.

(*d*) What is a "dead-end state" in a finite automata ? Explain with an example. 2

(*e*) Write the regular expression for the language having words in which *a* appears tripled (in clumps of 3), if at all. 2

(*f*) Describe the language for the given finite automata : 3



(*g*) Build a finite automata that have only those words that have length fewer than four letters. 3

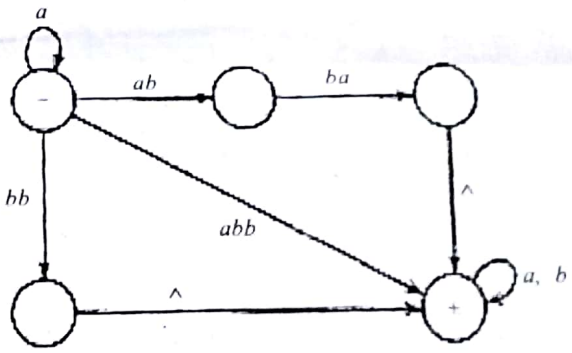
(*h*) Design a turing machine that erases all characters in its tape. 3

(*i*) Describe the language for the following regular expression : 4

(*i*) bba*(a + b)

(*ii*) ((a + b)a)*.

(*j*) Using bypass algorithm, convert the following transition graph into a regular expression : 4



(*k*) Construct a PDA for a language 4

L = {a^nS, where S starts with b and Length (S) = n}.

P.T.O.

(*f*) Using pumping lemma, show that language 4

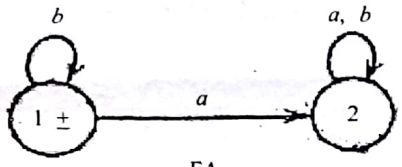
$\{a^n b^n$ where n is square of 1, 2, 3,.....$\}$

= {ab, aaaabbbb, aaaaaaaaabbbbbbbbb,.....}

is non-regular.

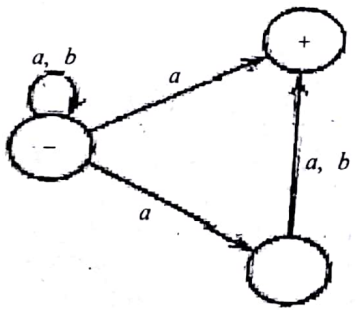
Section B

2. (*a*) Given finite automata machine FA_1. Using Kleene's theorem algorithm, find $(FA_1)^*$: 5



FA_1

(*b*) Convert the following non-deterministic finite automata to deterministic finite automata : 5



3. (*a*) For the following pairs of regular language, build a finite automata and regular expression that define $L_1 \cap L_2$: 4+2=6

L_1 : $(ab^*)^*$

L_2 : $a(a + b)^*$.

(*b*) Prove that the language 4

$\{a^n b^n c^n$ where n = 1, 2, 3, 4.....$\}$

is non-context free.

4. (*a*) Find the CFG for the language containing all words that have different first and last letters. 5

(*b*) Show that the following CFG is ambiguous : 5

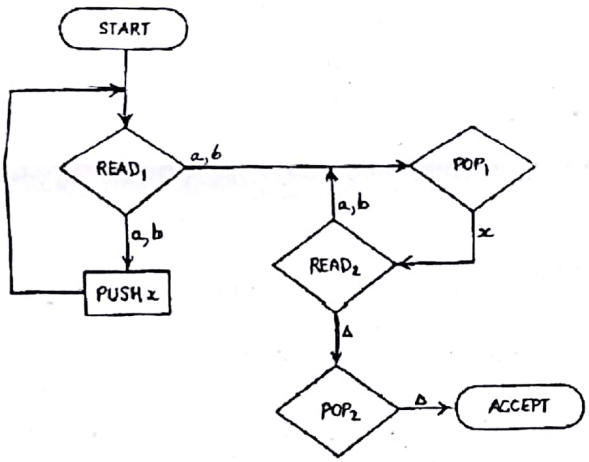
$S \rightarrow XaX$

$X \rightarrow aX|bX| \wedge$.

5. (*a*) Describe universal Turing Machine. 4

(*b*) Prove that a language is recursive language then its complement L' is also recursive. 6

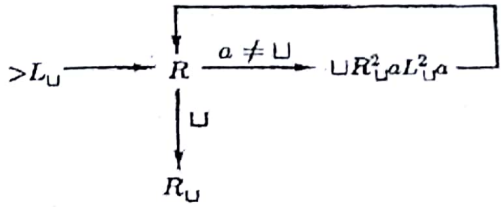
6. (*a*) Given a PDA :



(*i*) Write the language represented by this PDA. 2

(*ii*) Trace the PDA for the string *bbba*. 4

(*b*) Describe the function of the following Turing Machine using the string $\sqcup w \sqcup$ where *a* is any letter from alphabet set : 4



7. (*a*) If $\Sigma = \{x\}$, then what is Σ^+ ? Is $\Sigma^+ = \Sigma^*$? 2

(*b*) Build a finite automata that accepts only those words that do not end with *ba*. 4

(*c*) Prove that if L_1 and L_2 are Regular Languages, then $L_1 + L_2$, $L_1 L_2$ are also Regular Languages. 4

[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 779 **G** **Your Roll No.....**

Unique Paper Code : 234501

Name of the Paper : Theory of Computation (CSHT-511)

Name of the Course : **B.Sc. (H) Computer Science**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **All** questions from **Part A** is compulsory and attempt any **four** questions from **Part B.**
3. Assume $\Sigma = \{a,b\}$ is the underlying alphabet unless mentioned otherwise. Parts of a question must be answered together.

PART A

1. (a) Prove that for all sets S, $(S^+)^+=S^+$. (2)

   (b) Give regular expression for the language of all words that have at least two a's in them. (2)

   (c) Consider the language PALINDROME over the alphabet {a b}. Prove that if x is in PALINDROME then so is x^n for any n. (3)

   (d) Show that (a*+b)* and (a+b)* defines the same language over alphabet {a b}. (3)

   (e) Build an FA that accepts only those words that have more than four letters. (3)

P.T.O.

(f) Build FA for the regular expression (a+b)b(a+b)*. (3)

(g) Find a CFG for the language defined by regular expression (baa + abb)*. (3)

(h) Use the pumping lemma to show that the language $\{a^n b^n a^n\ n= 1\ 2\ 3...\}$ is non regular. (4)

(i) Show that if L1 and L2 are regular languages, then so are $L_1 + L_2$, L_1L_2 and L_1^*. (4)

(j) Construct a PDA for the language $L = \{a^{2n}b^n\ n=0\ 1\ 2\ 3\ ...\}$. (4)

(k) Explain the Church Turing Thesis. (4)

PART B

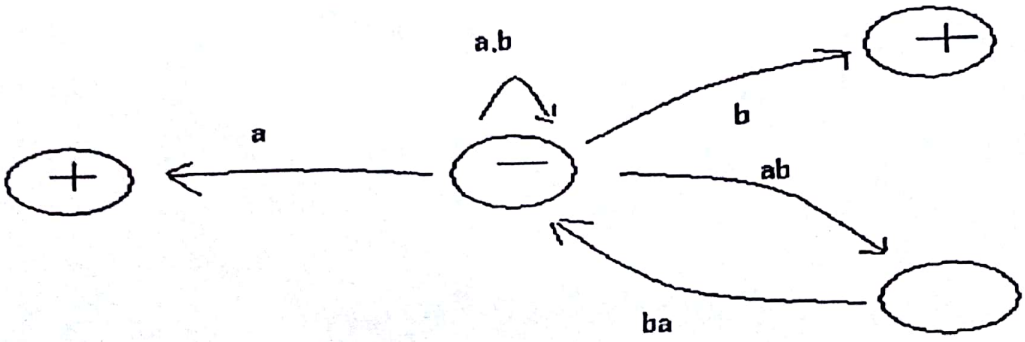
2. (a) Define Finite Automata. (2)

(b) Build a regular expression for all words that have exactly two b's or exactly three b's not more. (3)

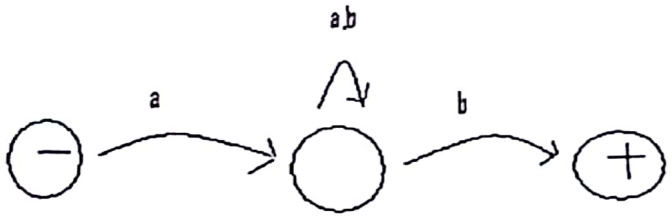
(c) Build an FA that accepts only those words that begin or end with double letter. (5)

3. (a) Define Non Deterministic Finite Automaton. (2)

(b) Convert the following Transition graph into regular expression. (4)



(c) Convert the following NFA into DFA : (4)



4. (a) For the given languages L1 = (a+b)b(a+b)* and L2 = b(a+b)*, find regular expression and finite automata that define $L_1 \cap L_2$. (5)

(b) Use pumping lemma to show that language $\{a^{2n}b^n\ n = 1\ 2\ 3\ ...\}$ is non regular. (5)

5. (a) Construct a CFG for the language L = $\{a^m b^n\ n>m, m, n>=1\}$. (5)

(b) Construct a PDA for the language L = $(a^n bb^n\ n=1\ 2\ 3\ ...\}$. (5)

6. (a) State pumping lemma for context free languages. (2)

(b) Show that the family of context free languages is not closed under intersection. (4)

(c) Show that the language $\{a^n b^n a^n b^n a^n$ for $n = 1\ 2\ 3\ ...\}$ is non context free. (4)

7. (a) Define Turing Machine. (2)

(b) Prove that If L is a recursive language, then its compliment L' is also recursive. (4)

P.T.O.

(c) Design a Turing Machine that provides output as a compliment of the given number which is provided to the machine as input in binary form over the alphabet {01}. (4)

(24)

This question paper contains 4+2 printed pages]

Your Roll No.....

1997

B.Sc. (H) Computer Science **G**

VI Semester

Paper 601—Theory of Computation

(New Course)

(Admission of 2001 and onwards)

Time : 3 *Hours* *Maximum Marks* : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer *All* questions. Parts of a question must be answered together.

1. (*a*) Prove that for all sets S,

$$(S^+)^* = (S^*)^*.$$ 2

(*b*) Find equivalent regular expression for :

$$(a + b)^* a (a + b)^* b (a + b)^*.$$ 2

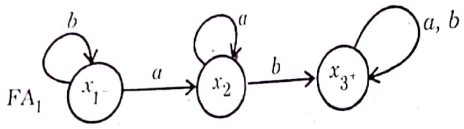
2. (*a*) Build an FA that accepts all strings of length four or more such that the next-to-last letter is equal to the second letter of the input string (over $\Sigma = \{a, b\}$). 4

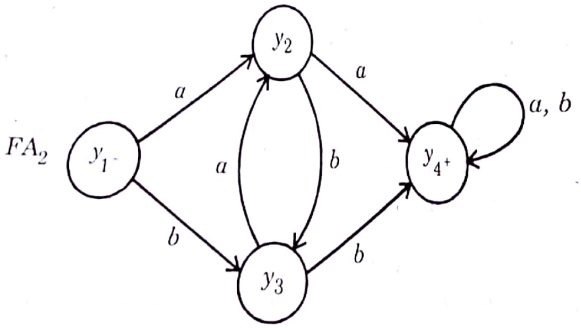
P.T.O.

(b) Prove that set of regular languages is closed under union, concatenation and Kleene closure. 3

3. (a) Define Kleene's theorem. 2

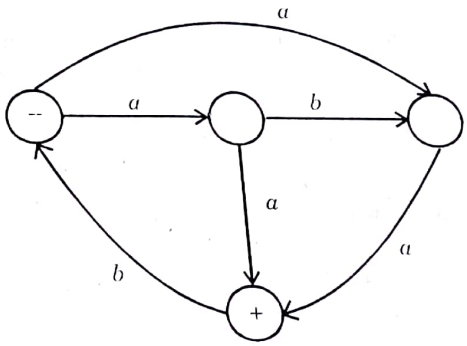
(b) Given two FA's, using algorithm of Kleene's theorem construct FA for $FA_1 + FA_2$. 5



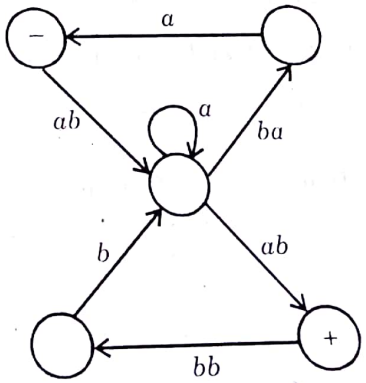


Also write the regular expression for these three FA's.

4. (a) Construct DFA for the following NFA : 5



(b) Convert TG into regular expression : 5



P.T

5. (a) Using pumping Lemma to show that the language :

$\{a^n\ b^n\ a^m$ where $n = 0, 1, 2, \ldots$ and $m = 0, 1, 2, \ldots\}$

is non-regular. 5

(b) Given two languages :

$L_1 = (b + ab)^* (a + \wedge)$

$L_2 = (a + b)^* aa (a + b)^*$

Find regular expression and FA that define the language $L_1 \cap L_2$. 7

6. (a) Find CFG for the language of all words that have different first and last letters over the alphabet $\Sigma = \{a, b\}$. 5

(b) Show that following CFG is ambiguous. 5

$S \rightarrow aSX \mid \wedge$

$X \rightarrow aX \mid a$

Find its unambiguous CFG that generates same language.

7. Consider the following CFG :

$S \rightarrow aSb \mid ab$

(a) Write language accepted by this CFG. 2

(b) Convert this CFG into CNF. 3

(c) Build PDA for this CNF. 5

8. (a) Prove that A language is recursive if and only if both it and its complement are recursively enumerable. 4

(b) Write Random Access Turing Machine program which describe the language :

$\{a^n\ b^n\ c^n : n \geq 0\}$. 5

9. (a) Consider the TM

$M = (K, \Sigma, \delta, S, H)$

where

$K = \{q_0, h\}$, $\Sigma = \{a, \sqcup, \triangleright\}$,

$S = q_0$, $H = \{h\}$

and δ is given by :

q	σ	$\delta(q, \sigma)$
q_0	a	$(q_0, \leftarrow)$
q_0		$(h, \sqcup)$
q_0	a	$(q_0, \rightarrow)$

Describe the operation of this turing machine. 3

(b) If L is a language such that :

L = {"M" "W" : M halts on W}

Prove that it is an undecidable problem. 3

Nov-2008

(27)

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[This question paper contains 4 printed pages.]

Your Roll No. 2013005....

1693

B.Sc. (H) Computer Science/VI Sem.

(I)

Paper – 601 : Theory of Computation

(For Admissions of 2001 and onwards)

Time : 3 Hours **Maximum Marks : 75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Note : Answer **all** questions. Parts of a question must be answered together.
Assume alphabet $\Sigma = \{a, b\}$ unless stated.

1. (a) Define a Regular Expression. 2

(b) Write regular expression for the languages accepting all words that 2 + 2 + 2

(i) contain at least one of the strings **aba** or **bbbb**.

(ii) end in **aa** or **bb**

(iii) have odd number of **a**'s

(c) Rewrite the regular expression 2

```
(a*b)* + (b*a)*
```

as simpler expression describing the same language.

2. (a) Prove that set of regular languages is closed under intersection. 3

(b) For the pair of regular languages, find systematically a regular expression and a FA (Finite Automata) that define $L_1 \cap L_2$. 6

L_1 = (a + b)* a

L_2 = (a + b)* aa (a + b)*

3. Let SQUARE be a language defined as

SQUARE = {a^n; n is square of an integer and ≥ 1}

= {a, aaaa, aaaaaaaaa, ...}

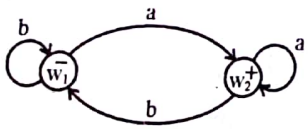
Is SQUARE regular ? Justify. 5

4. Write regular expression and construct Deterministic Finite Automata for the language. 4 + 4

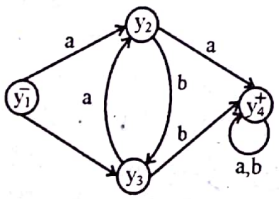
(a) having strings with exactly one occurrence of the substring aaa.

(b) having words that have an even number of substrings ab.

5. Given the following Finite Automata, find $FA_1 FA_2$ systematically. 6

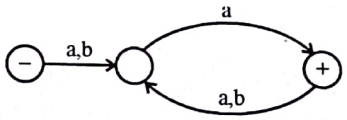


FA_1

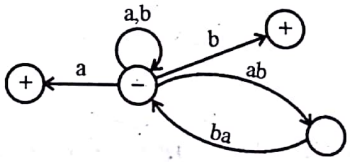


FA_2

6. Systematically transform the following Nondeterministic Finite Automata (NFA) into equivalent Deterministic Finite Automata (DFA). 4



7. Convert the following Transition Graph (TG) into regular expression using Bypass algorithm. 4



8. (a) Give Context Free Grammar (CFG) for the following : 4 + 4

(i) language for all strings with triple b in them

(ii) $\{a^i b^j c^k \mid i + j = k;\ i, j, k \geq 0\}$ and $\Sigma = \{a, b, c\}$

(b) Show that the following CFG is ambiguous : 4

S → X a X

X → a X | b X | ^

(c) Build pushdown automation (PDA) to accept the language : 4

$\{a^n b^{n+1};\ n \geq 1\}$

9. Prove that the language with $\Sigma = \{a, b, c\}$

$L_{abc} = \{a^p b^q c^r ; 0 \leq p < q < r\}$

is non-context free. 4

10. (a) Design left shifting turing machine $S_{\leftarrow}$ which transforms $\cup W \cup$, where W contains no blanks, into $W \cup$. 5

(b) Prove that if L is recursive language, then its complement $\bar{L}$ is also recursive. 4

Corrected by Veenu Bhasin (31347) 4/5/10 April, 2010 (Annual) 29

[This question paper contains 5 printed pages.]

Your Roll No......

6202 **J**

B.Sc. (H) Computer Science/VI Sem.

Paper—601 : Theory of Computation

(For Admissions of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **all** *questions.*

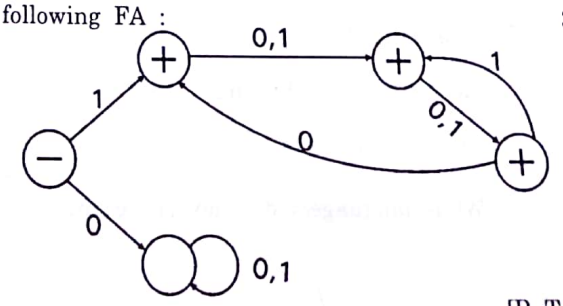
Parts of a question must be answered together.

Assume alphabet $\Sigma = \{a, b\}$ unless specified.

1. (a) Consider the language S = {aa, ba, ab, bb}. Describe the language S*. 2

(b) Write a regular expression for the language of all words with an odd number of a's. 2

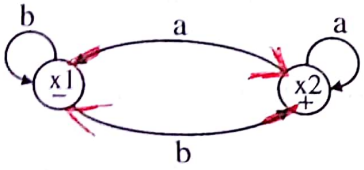
(c) Describe in English the language accepted by the following FA : 3



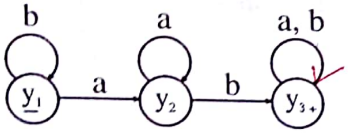
[P. T. O.

2. (a) Build a D.F.A. that accepts the language of all strings of length 4 or more such that the next-to-last letter is equal to the second letter of the input string. 5

(b) Construct FA for the language (FA1 + FA2), where FA1 & FA2 are given below : 5



FA1



FA2

3. Let L = All strings that end with aa or bb. Construct a DFA for L and L′ (*i.e.*, Complement of L). 6

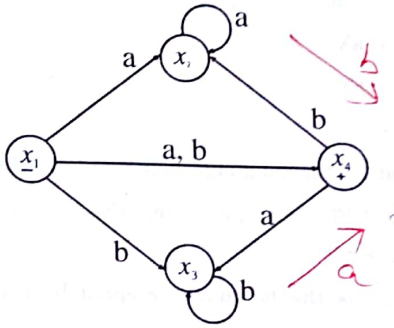
4. (a) Do the following two regular expressions describe the same language : 3

$(a + b)^* \; a(a + b)^* \; a(a + b)^*$

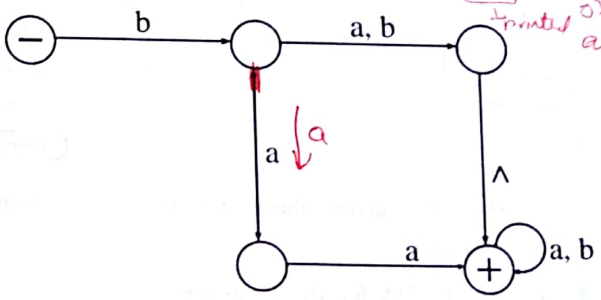
$b^* \; ab^* \; a(a + b)^*$

What language/s do they represent?

(b) Convert the following NFA to DFA : 5



5. (a) Convert the following automaton into regular expression (using bypass algorithm) : 4



(b) Is the language $\{a^n \; b^{n+1}\}$ regular? Justify using Pumping Lemma. 4

[P. T. O.

6. (a) Consider the following CFG :

$S \rightarrow XaaX$

$X \rightarrow aX$

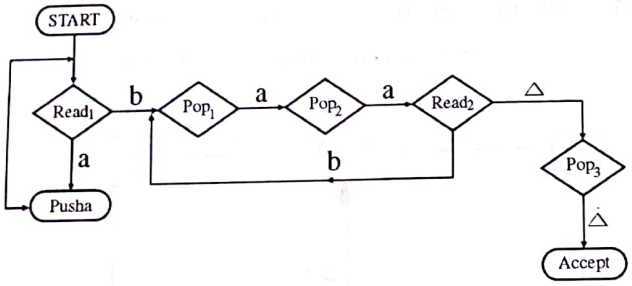
$X \rightarrow bX$

$X \rightarrow \Lambda$

What is the language generated by this CFG? 3

(b) Give CFG that generates the regular language $(aaa + b)^*$. 4

7. (a) What is the language accepted by the following PDA? 4



Is the PDA given above deterministic or non-deterministic.

(b) Construct PDA for the language : 5

$L = \{a^m\ b^n\ a^{m+n},\ n \geq 1,\ m \geq 1\}$.

8. Show that the language $\{a^n\ b^n\ c^n\ d^n \mid n = 1, 2, 3,...\}$ $= \{abcd, aabbccdd, ...\}$ is not context free. 5

9. Design a Turing Machine 'Flip' which changes all a's in input string to b's and change all b's in input string to a's. 5

Example : Given input $\triangleright\sqcup$ abaa, the output will be $\triangleright\sqcup$ babb.

10. (a) What is a Universal Turing Machine? Give its functional notation. 4

(b) Let M = (K, Σ, δ, s, {h}), where

$K = \{q_0, q_1, q_2, h\}$

$\Sigma = \{a, b, \sqcup, \triangleright\}$

$s = q_0$

and δ is given by the following table (the transitions on Δ are $\delta(q, \triangleright) = (q, \triangleright)$, and are omitted). 6

q	σ	δ(q, σ)
q_0	a	$(q_1, \leftarrow)$
q_0	b	$(q_0, \rightarrow)$
q_0	$\sqcup$	$(q_0, \rightarrow)$
q_1	a	$(q_1, \leftarrow)$
q_1	b	$(q_2, \rightarrow)$
q_1	$\sqcup$	$(q_1, \leftarrow)$
q_2	a	$(q_2, \rightarrow)$
q_2	b	$(q_2, \rightarrow)$
q_2	$\sqcup$	h, $\sqcup$

Trace the computation of M starting from the configuration $(q_0, \triangleright abb\sqcup\ bb\ \sqcup\sqcup\sqcup aba)$.

April, 2006.

This question paper contains 4+1 printed pages]

(32)

Your Roll No.....

6343

B.Sc. (H) Computer Science

VI Semester

Paper 601—Theory of Computation

(New Course)

(Admission of 2001 and onwards)

Time : 3 *Hours* *Maximum Marks* : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer *All* questions. Parts of a question must be answered together.

1. (*a*) Convert the following CFG to CNF :

FA → 41
CFGs/PDA → 15
Turing machine → 19
75

$S \rightarrow XaX \mid bX$

$X \rightarrow XaX \mid XbX \mid c$

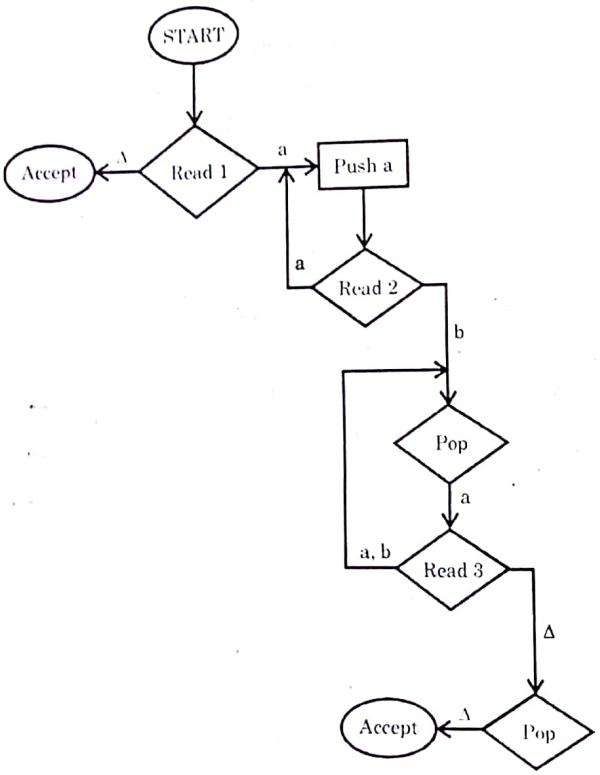
The terminals are a, b and c. 4

(*b*) Build PDA for the language $\{a^n b^m a^m b^n$: where n and m are independent integers$\}$. 5

P.T.O.

2. What is the language accepted by the following PDA ?

Find a CFG that generates this language. 6

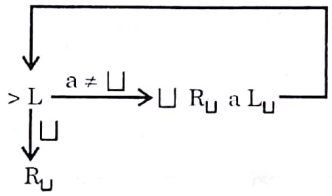


3. (a) Design a Turing Machine that computes function $f(w) = ww^R$ where w is a string in $\{a, b\}^*$. 5

(b) Describe the Church-Turing thesis. 3

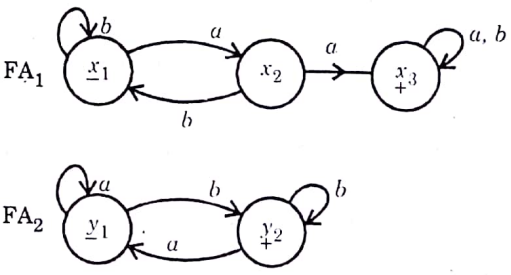
4. (a) Prove that if a language L is recursive, then it is recursively enumerable. 5

(b) Trace the computation of the following turing machine starting from the configuration ▷␣aabb␣.



Describe what M does. 6

5. (a) Given the FAs as follows, construct the FA for the language $FA_1 + FA_2$.



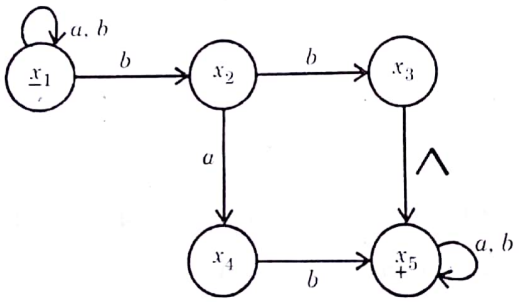
Describe the languages represented by these three FAs. 7

P.T.O.

(b) Construct an NFA that accepts the language :

$(abab^* + aba^*)ba$. 4

6. (a) Construct a DFA equivalent to the following NFA. Also, write a regular expression for the language represented by this NFA. 5



(b) Construct FA accepting the following language :

$\{w \in \{a, b\}^* : w$ does not contain bbb as substring$\}$. 5

7. (a) Construct FA that accepts only those strings that have $abab$ as substring. 4

(b) Using Pumping Lemma show that language $a^\wedge b^\wedge$ is non-regular where $\Sigma = \{a, b\}$. 4

8. (a) Define KLEENE closure with example. 2

(b) Give a set S such that S^* only contains all possible strings of a's and b's that have length divisible by two. 2

9. For the following pair of regular languages, find a regular expression and an FA that define $L_1 \cap L_2$.

$L_1 = (a + b)^* c$

$L_2 = b(a + b)^* c$

where $\Sigma = \{a, b, c\}$. 8

April '2011

(35)

This question paper contains 4 printed pages.]

1803

Your Roll No. .....

B.Sc. (H) Computer Science / VI Sem. **A**

Paper 601 : Theory of Computation

(For Admissions of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

*Attempt **all** questions.*

Parts of a question must be answered together.

1. (a) Assume Alphabet $\Sigma=\{a, b\}$ unless stated. Consider the language S^*, where $S=\{ab, ba\}$

(i) Write out all the words in S^* that have seven or fewer letters.

(ii) Can any word in this language contain the substring aaa or bbb ?

(iii) What is the smallest word not in S^* ?

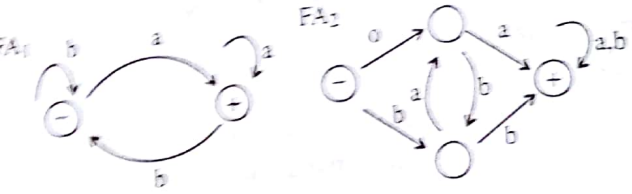
4+1+1

(b) Write a regular expression for the set of all words with no two consecutive a's. 2

[P.T.O.

(a) Build a DFA that accepts only those words that have even numbered occurrences of substring ab. 5

(b) Construct FA for the language ($FA_1 + FA_2$) where FA_1 and FA_2 are given below. 5



(c) Design a DFA that starts with a and has odd number of a's or starts with b and has even number of b's. 3

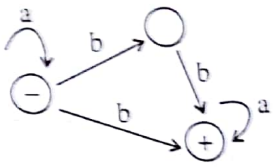
(a) Prove that the set of regular language is closed under interaction. 3

(b) For the pair of regular language Find systematically a regular expression and a FA that define $L_1 \cap L_2$

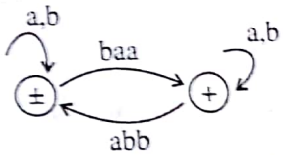
$L_1 = (a + b)\, b\, (a + b)^*$

$L_2 = b\, (a + b)^*$ 6

4. Convert NFA into DFA. 5



5. (a) Convert TG into Regular expression 7



(b) Use pumping lemma to show that the following language is non-regular

$\{a^n b^{2n}$ for $n > 1\}$. 5

6. (a) Consider CFG

$S \rightarrow XYX$

$X \rightarrow aX|bX|\wedge$

$Y \rightarrow bbb$ 3

(b) Obtain a CFG to generate a language of all non-palindromes over $\Sigma=\{a, b\}$. 4

7. Design a PDA to accept the following language over $\Sigma=\{0, 1\}$

$\{a^n b^n \mid n = 0\ 1\ 2 \ldots\}$ 6

8. (a) Design a Turing Machine which accepts the language
$L(\mu) = \{ a^n b^n c^n \mid n \geq 1 \}$ 5

(b) Prove that the recursive languages are closed under complementation. 3

(c) Consider $\Sigma = \{0\ 1\}$, design a Turing Machine that multiplies the value of the input string over Σ by 2. 4

(d) Describe Universal Turing Machine. 3

(37) May, 2012

[This question paper contains 5 printed pages.]

6628

Your Roll No.....

B.Sc. (H) Computer Science / VI Sem. **B**

Paper 601 : Theory of Computation

(Admissions of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. **1** *is compulsory. Attempt any* **four** *from the rest. Assume* $\Sigma = \{a, b\}$ *for all the questions unless specified otherwise. Parts of a question must be answered together.*

1. (a) What is a recursive language ? Illustrate with the help of an example. (4)

(b) Write a regular expression for the set of all words that end in double letter. (3)

(c) Give a grammar for the language of odd palindromes. (3)

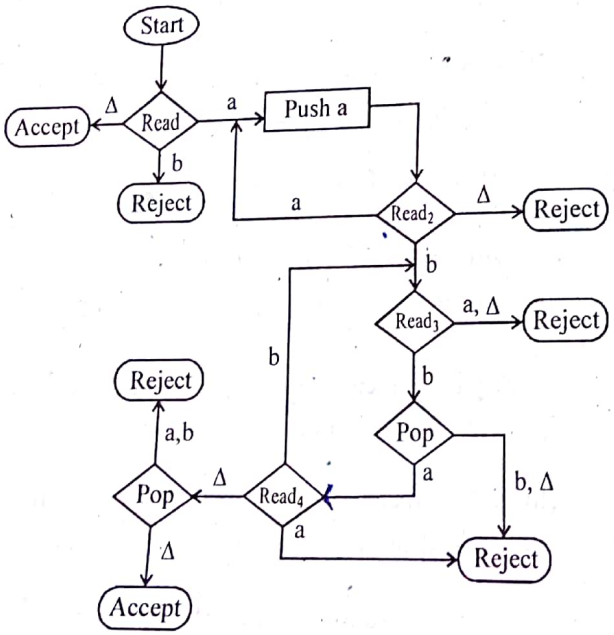
(d) Give FA that accepts all words with different first and last letters. (5)

P.T.O.

(e) Prove the language $a^n b^n a^n$ for n = 1 2 3 ... is non context–free. (5)

(f) Show that the CFG S->aS | Sa | a is ambiguous. (4)

(g) What is the language accepted by the following PDA ? Find a CFG that generates this language. (4)



(h) State Kleene's Theorem. (2)

(i) Design a Turing machine that computes the function f(m) = m+2, where m is a positive binary number. (5)

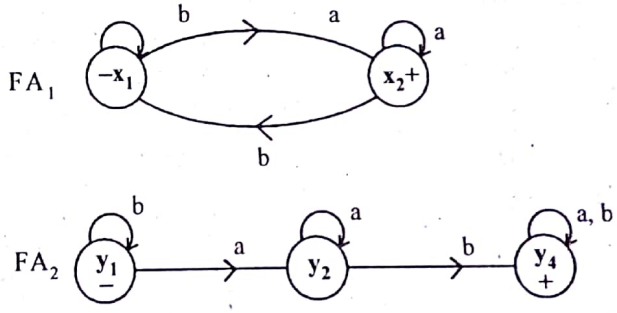
2. (a) Show that (a + b) *= (a + b)*ab (a+b)* + b*a*. (3)

(b) Give regular expression for the language L where L = $\{a^n b^m \mid m \geq 0, n \geq 3\}$. (2)

(c) If S = {a, b} and T*=S*. Prove that T must contain S. (3)

(d) Describe the language associated with the regular expression (a(aa)*b(bb)*)*. (2)

3. (a) Construct FA for language FA_1FA_2 where FA_1 and FA_2 are given below : (4)



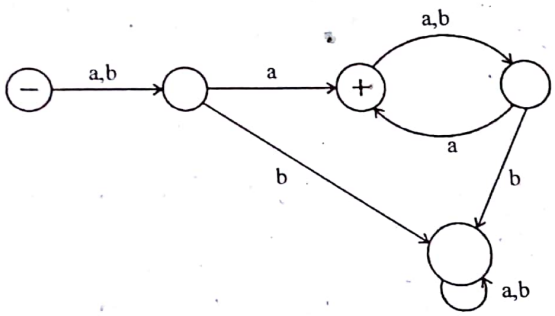
(b) Construct Fas for the language L_1 and L_2 as given below.

L_1 = (a + b) b(a + b)*, L_2 = b(a + b)*

Find a regular expression and FA's that define $L_1 \cap L_2$. (6)

P.T.O.

4. (a) Using the bypass algorithm, convert the following TG into regular expression. (5)



(b) Write a CFG for the language over the alphabet. = {a, b} consisting of all words with no three consecutive b's. (5)

5. (a) Draw a PDA for the language

$\{a^n b^n a^m$, where n,m = 1,2,3,...$\}$ (5)

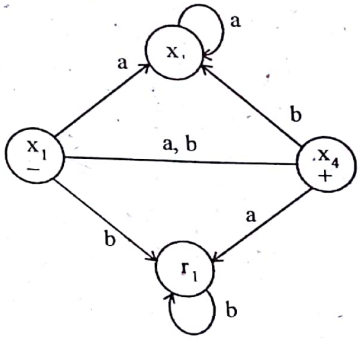
(b) Show that the language

$\{a^m b^n$ where $m = 2n + 1, n \geq 1\}$ is not regular. (5)

6. (a) Design a copying machine C which transform UwU into UwUwUwhere w contain no blanks. (5)

(b) Describe Universal Turing Machine with the help of suitable notations. (5)

7. (a) Convert the following NFA into DFA (5)



(b) Are Context free languages closed under Intersection ? Explain with example. (5)

This question paper contains 4+1 printed pages]

March - 2006.

Your Roll No.....

(1)

6343

B.Sc. (H) Computer Science **F**

VI Semester

Paper 601—Theory of Computation

(New Course)

(Admission of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

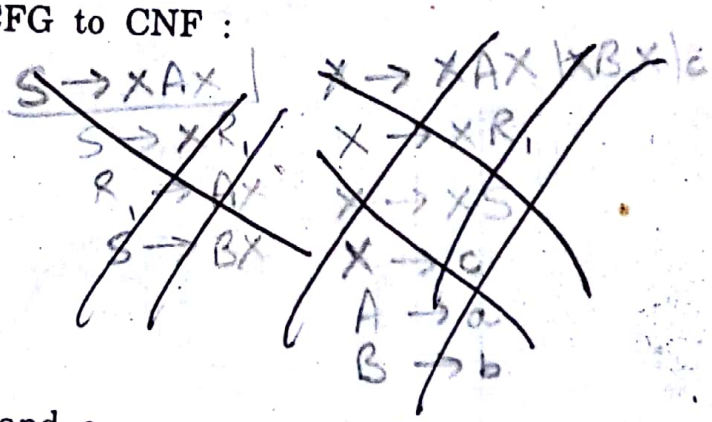
(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer *All* questions. Parts of a question must be answered together.

1. (a) Convert the following CFG to CNF :

$S \rightarrow XaX \mid bX$

$X \rightarrow XaX \mid XbX \mid c$

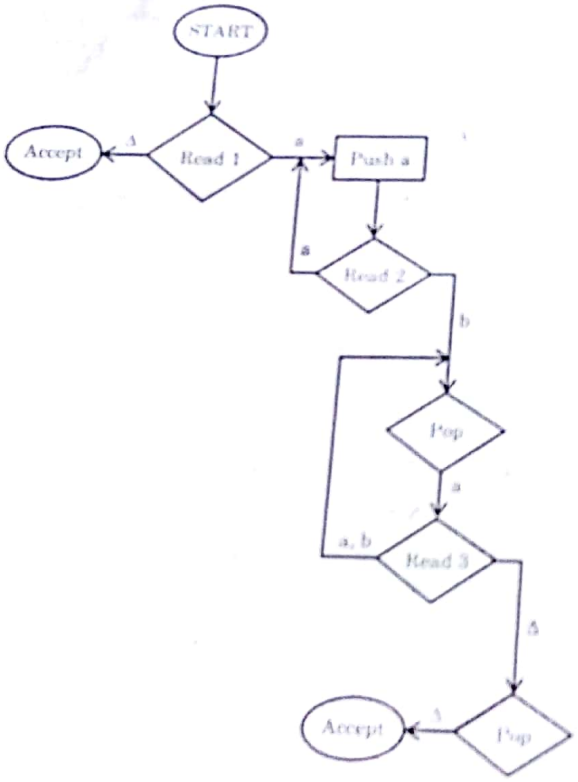


The terminals are a, b and c. 4

(b) Build PDA for the language $\{a^n b^m a^m b^n$: where n and m are independent integers$\}$. 5

P.T.O.

2. What is the language accepted by the following PDA ? Find a CFG that generates this language. 6

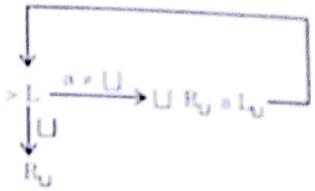


(a) Design a Turing Machine that computes function $f(w) = ww^R$ where w is a string in $[a, b]^*$. 5

(b) Describe the Church-Turing thesis. 3

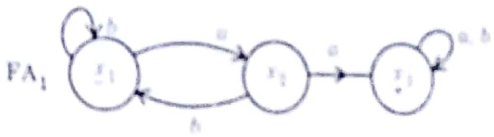
4. (a) Prove that if a language L is recursive, then it is recursively enumerable. 5

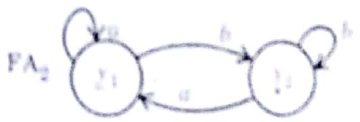
(b) Trace the computation of the following turing machine starting from the configuration [▷ ␣ aabb ␣



Describe what M does. 6

5. (a) Given the FAs as follows, construct the FA for the language $FA_1 \cdot FA_2$.





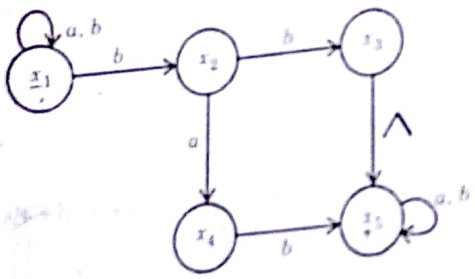
Describe the languages represented by these three FAs. 7

PTO

Construct an NFA that accepts the language

$(abab^* + aba^*)ba$. 4

(a) Construct a DFA equivalent to the following NFA. Also, write a regular expression for the language represented by this NFA. 5



(b) Construct FA accepting the following language :

$\{w \in \{a, b\}^* : w$ does not contain bbb as substring$\}$. 5

(a) Construct FA that accepts only those strings that have $abab$ as substring. 4

(b) Using Pumping Lemma show that language [illegible] is non-regular where $\Sigma = \{a, b\}$. 4

(a) Define KLEENE closure with example. 2

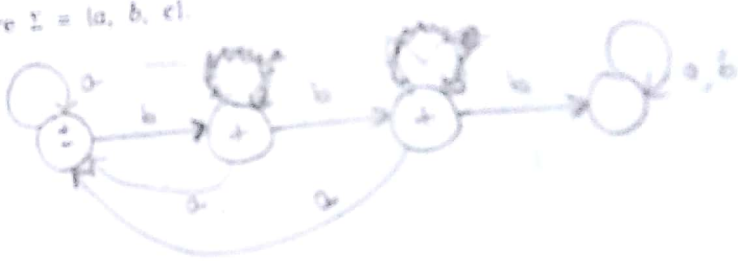
(b) Give a set S such that S^* only contains all possible strings of a's and b's that have length divisible by two. 2

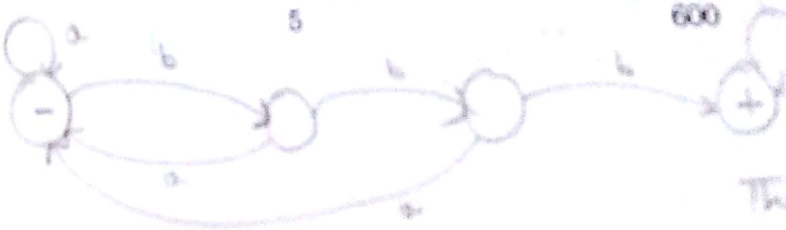
For the following pair of regular languages, find a regular expression and an FA that define $L_1 \cap L_2$.

$L_1 = (a + b)^* c$

$L_2 = b(a + b)^* c$

where $\Sigma = \{a, b, c\}$. 8





March, 2007.

(2)

This question paper contains 4+2 printed pages]

Your Roll No.....

1997

B.Sc. (H) Computer Science **G**

VI Semester

Paper 601—Theory of Computation

(New Course)

(Admission of 2001 and onwards)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer *All* questions. Parts of a question must be answered together.

1. (*a*) Prove that for all sets S.

$$(S^+)^* = (S^*)^*.$$ 2

(*b*) Find equivalent regular expression for :

$$(a + b)^* a (a + b)^* b (a + b)^*.$$ 2

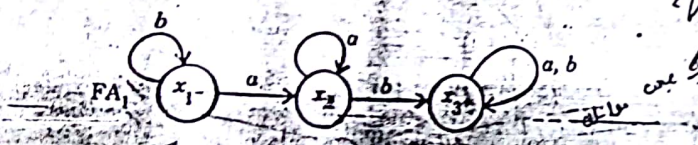
2. (*a*) Build an FA that accepts all strings of length four or more such that the next-to-last letter is equal to the second letter of the input string (over $\Sigma = \{a, b\}$). 4

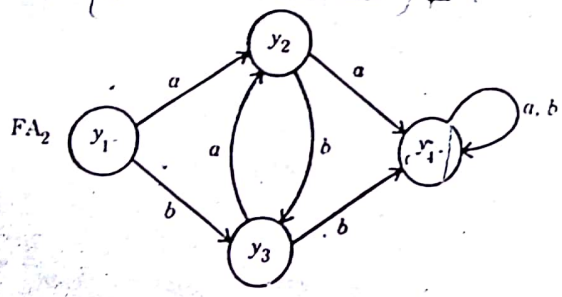
P.T.O

(b) Prove that set of regular languages is closed under union, concatenation and Kleene closure. 3

3. (a) Define Kleene's theorem. 2

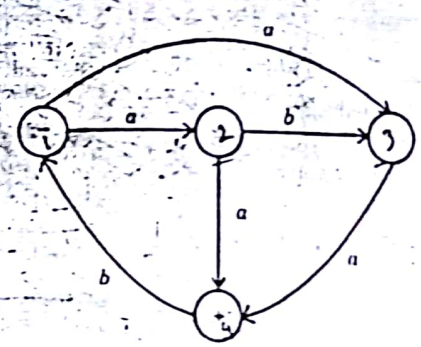
(b) Given two FA's, using algorithm of Kleene's theorem, construct FA for $FA_1 + FA_2$. 5



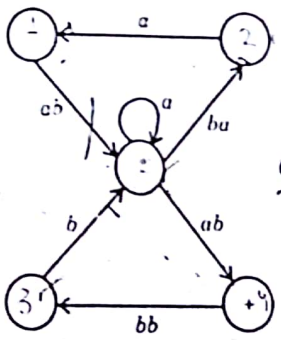


Also write the regular expression for these three FA's.

4. (a) Construct DFA for the following NFA : 5



(b) Convert TG into regular expression : 5



IS07

(a) Using pumping Lemma to show that the language :

$\{a^n b^n a^m$ where $n = 0, 1, 2, \ldots$ and $m = 0, 1, 2, \ldots\}$

is non-regular. 5

(b) Given two languages :

$L_1 = (b + ab)^* (a + \lambda)$

$L_2 = (a + b)^* aa (a + b)^*$

Find regular expression and FA that define the language $L_1 \cap L_2$ 7

8 (a) Find CFG for the language of all words $\ldots$ have different first and last letters over the alphabet $\Sigma = \{a, b\}$ 5

(b) Show that following CFG is ambiguous 5

$S \rightarrow aSX \mid a$

$X \rightarrow aX \mid a$

Find its unambiguous CFG that generates same language.

IS07

7 Consider the following CFG :

$S \rightarrow aSb \mid ab$

(a) Write language accepted by this CFG 2

(b) Convert this CFG into CNF 3

(c) Build PDA for this CNF 5

8 (a) Prove that A language is recursive if and only if both it and its complement are recursively enumerable. 4

(b) Write Random Access Turing Machine program which describe the language :

$\{a^n b^n c^n \mid n > 0\}$ 8

9 (a) Consider the TM

$M = (K, \Sigma, \delta, S, H)$

where

$K = \{q_0, q_1, q_2, \ldots, q_n\}$, $\Sigma = \{a, \ldots, z\}$

$S = q_0$, $H = \{h\}$

P T O

5. (a) Using pumping Lemma to show that the language

$\{a^n\ b^n\ a^m$ where $n = 0, 1, 2, \ldots$ and $m = 0, 1, 2, \ldots\}$

is non-regular. 5

(b) Given two languages :

$L_1 = (b + ab)\ (a + \wedge)$

$L_2 = (a + b)\ aa\ (a + b)$

Find regular expression and FA that define the language $L_1 \cap L_2$. 7

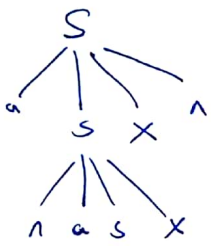
6. (a) Find CFG for the language of all words that have different first and last letters over the alphabet $\Sigma = \{a, b\}$. 5

(b) Show that following CFG is ambiguous. 5

$S \rightarrow aSX|\wedge$

$X \rightarrow aX|a$

Find its unambiguous CFG that generates same language.



7. Consider the following CFG :

$S \rightarrow aSb|ab$

(a) Write language accepted by this CFG. 2

(b) Convert this CFG into CNF. 5

(c) Build PDA for this CNF. 5

8. (a) Prove that A language is recursive if and only if both it and its complement are recursively enumerable.

(b) Write Random Access Turing Machine program which describe the language

$\{a^n\ b^n\ c^n : n > 0\}$

9. (a) Consider the TM

$M = (K, \Sigma, \delta, S, H)$

where

$K = \{q_0, h\}, \Sigma = \{a,$

$S = q_0, H = \{h\}$