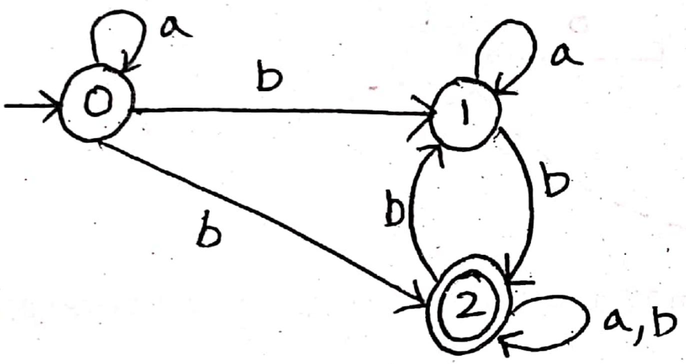
T.E. (Comp.) (Semester – V) (RC) Examination, May/June 2017
AUTOMATA LANGUAGES AND COMPUTATION

Duration : 3 Hours   Total Marks : 100

Instructions : ***Assume*** *data* ***wherever*** *required.*
Answer ***any 5*** *questions with atleast* ***one*** *from* ***each*** *Module.*

MODULE – 1

1. a) Convert the following non-deterministic finite automata to deterministic finite automata. **6**

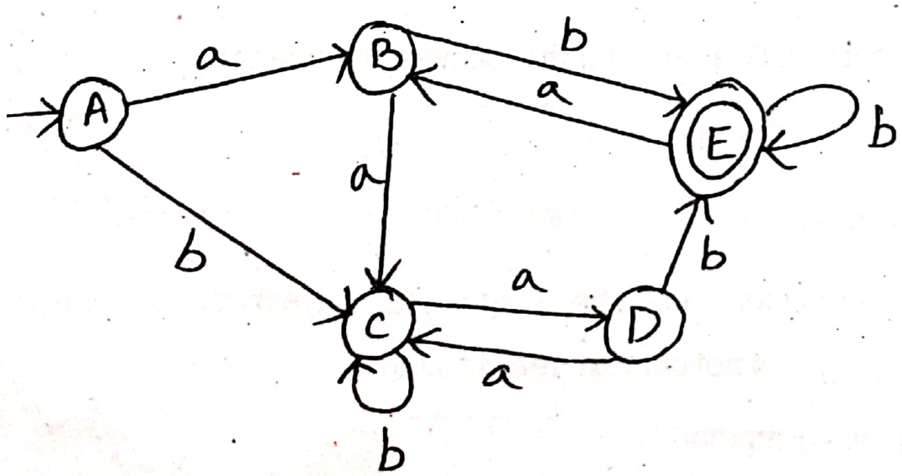


b) State pumping lemma and hence prove that the language $L = \{a^i b^i \mid i \geq 0\}$ is not regular. **6**

c) Construct NFA for the language :

$L(G) = \{X \in \{0, 1\}^* : X$ is starting with 1 and $|X|$ is divisible by 3$\}$ validate the string 1001110. **8**

2. a) Minimize the following DFA using table filling algorithm. **8**

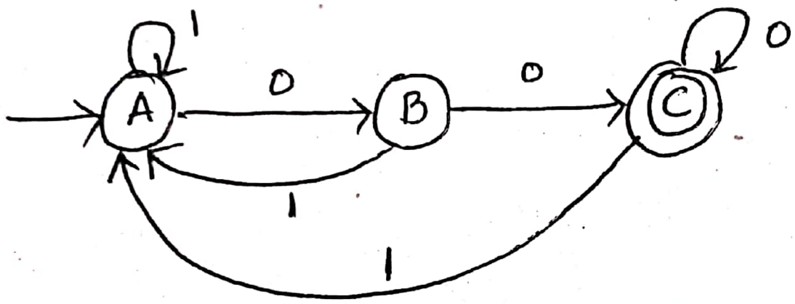


b) Prove that : "For any non-deterministic finite automata $M = (Q, \Sigma, q_0, A, \delta)$ accepting language $L \subseteq \Sigma^*$ there is an equivalent finite automata $M_1 = (Q, \Sigma, q_1, A_1, \delta_1)$ that also accepts L". 6

c) Construct a Mealy machine for odd parity checker. Convert this Mealy machine to an equivalent Moore machine. 6

MODULE – II

3. a) Construct a context free grammar for the following finite automata. 5



b) What is Greibach normal form ? Convert the following grammar into Greibach normal form :

$G = (\{Q, A, B, C\}, \{a, b\}, Q, P = \{Q \to a \mid AB, A \to a \mid BC, B \to b, C \to b\})$. 7

c) Design a PDA for the language :

$L = \{W \mid n_a(w) > n_b(w)\}$. 8

4. a) Prove that : "If L_1 and L_2 are context free languages then $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are also context free languages". 6

b) Construct context free Grammar for the following languages : 6

i) $L = \{a^{n+2} b^m \mid n \geq 0 \text{ and } m > n\}$

ii) $L = \{W \subset W^R \mid W \in \{a, b\}^*\}$.

c) State pumping lemma for context free languages. Prove that the language $L = \{a^n b^{2n} a^n \mid n \geq 0\}$ is not context free language. 6

d) What is ambiguous grammar ? 2

MODULE – III

5. a) Construct a turing machine that accepts the language $L = \left\{ SS \mid S \in \{a, b\}^* \right\}$. 8

b) Design a turing machine to reverse a given string $W \in \{a, b\}^*$. 7

c) What is universal turing machine ? Explain its working. 5

6. a) Construct a turing machine to recognize the language $L = \left\{ a^n b^n c^n \mid n \geq 1 \right\}$. 8

b) Construct a turing machine that accepts string that begin and end with same symbol where $\Sigma = \{0, 1\}^*$. 6

c) Write short note on :

i) Church hypothesis

ii) Non-deterministic turing machine. 6

MODULE – IV

7. a) Construct unrestricted grammar for the following language :

$L = \left\{ a^i b^i c^i \mid i \geq 1 \right\}$. 8

b) Write short notes on : 8

i) Unsolvable decision problem

ii) Rice theorem.

c) What is generalized sequential machine ? 4

8. a) Write short notes on :

i) Halting problem

ii) Linear bounded automata. 8

b) Prove that : "Classes of recursively enumerable languages are closed under union operation". 8

c) What is Chomsky hierarchy ? 4

T.E. (Computer) (Semester – V) (RC 2007-08) Examination, Nov./Dec. 2017
AUTOMATA LANGUAGES AND COMPUTATIONS

Duration : 3 Hours Max. Marks : 100

Instructions : *i) Attempt **any five** questions by selecting **at least one** question from **each** Module.*
*ii) Make suitable assumptions **if required.***
*iii) The symbol λ denotes a **null** string.*

MODULE – I

1. a) Prove the following by mathematical induction for all $n \geq 0$, $5^n - 2^n$ is divisible by 3. **4**

b) Construct DFA for the following languages **(any two)** : **6**

i) $L(M) = \{w \in \{0, 1\}^* | w$ contains even no. of 0's and $|w|$ is divisible by 3$\}$

ii) $L(M) = \{w \in \{a, b, c\}^* \mid |w| \bmod 5 \neq 0$ and w does not contain abc$\}$

iii) $L(M) = \{w \in (aba + bab) \mid w \in \{a, b\}^*\}$

c) Design a finite state machine that compares two binary numbers to determine whether they are equal and which of the two is smaller. Assume that the digits of the two numbers come in one by one with the lowered digit coming in first. **5**

d) Construct a regular expression to represent the following DFA.
$M = (\{A, B, C, D\}, \{0, 1\}, \delta, A, \{B, D\})$ where δ: $\{\delta(A, 0) = C, \delta(A, 1) = B, \delta(B, 0) = D, \delta(B, 1) = A, \delta(C, 0) = B, \delta(C, 1) = C, \delta(D, 0) = A, \delta(D, 1) = C\}$. **5**

2. a) Construct a Mealy machine for the following process : for input from $\{0, 1\}^*$ if the input ends in 1001 output A; if the input ends in 1111 output B, if the input ends in 1010 output C, else output D. Obtain an equivalent Moore Machine for the same. **6**

b) Construct the NFA-λ (NFA with empty transitions) for the regular expression $01^*0 + (0^*1^+)^*110$. Convert the NFA-λ to minimized DFA. **8**

c) Prove that the language $L(M) = \{0^m1^n | m \neq n\}$ is not a regular language. **4**

d) Explain the closure properties of regular sets. **2**

P.T.O.

MODULE – II

3. a) Construct the CFG for the language : $L = \{a^n b^m c^o d^p | n+m=o+p\}$. Convert the CFG to GNF. 6

b) Prove that the language $L(M) = \{a^{2n} b^n c^n | n \geq 1\}$ is not a CFL. 4

c) Simplify the following CFG. 6

$G = (\{S, A, B, D\}, \{a,, b, d\}, P = \{S \to aAbB \mid AD \mid BD \mid \lambda, A \to aA \mid B \mid \lambda,$

$B \to Bb \mid D \mid \lambda, D \to DA \mid DB \mid D \mid d\}, S)$

d) Explain the following **(any two)** : 4

i) Ambiguity

ii) Nullable variables

iii) Configuration of a PDA.

4. a) Construct PDA for the language $L(M) = \{0^n 1^m 2^{2m} | n, m \geq 0\}$. Explain the behavior of the pushdown automata with the help of a string. 6

b) Convert CFG into PDA.

$G = (\{S, A, B\}, \{a, b\}, \{S \to aB \mid bA, A \to a \mid aS \mid bAA, B \to b \mid bS \mid aBB\}, S)$. Explain the behavior of PDA with the help of a string bbaaba. 7

c) Construct the CFG for the given PDA $M = (\{A, B\}, \{a, b\}, (Z, X\}, \delta, A, Z, \phi)$ where δ is defined as $\{\delta(A, a, Z) = (A, XZ), \delta(A, a, X) = (A, XX),$ $\delta(A, b, X) = (B, X), \delta(B, b, X) = (B, X), \delta(B, a, X) = (B, \lambda), \delta(B, \lambda, Z) = (B, \lambda)\}$.
(λ denotes a null string). 7

MODULE – III

5. a) Design a Turing Machine which computes the sum of two binary numbers. 7

b) Construct the Turing machine that recognize the following language $L = \{a^x | x = i^2, i \geq 1\}$. 7

c) Explain the following : 6

i) Nondeterministic Turing machine.

ii) Universal Turing machine.

6. a) We do not define λ-transition for a TM. Why not ? Which feature of TM makes it unnecessary or inappropriate to talk about λ-transitions ? 4

b) Design a Turing machine which computers 2^n given n as input, where n is a non negative integer. Describe the behavior of the TM for n = 3. 8

c) Construct the Turing machine to computer the function f(x, y) = x – y, where x $\geq$ y, x and y are both positive integers. Assume that Turing machine uses unary notation. 8

MODULE – IV

7. a) Construct the Grammar that generates the language $L(G) = \{a^i | i$ is the power of 2$\}$. State the types of grammar generated. Validate the string aaaa. 6

b) Construct a unrestricted grammar for the language $L = \left\{a^i b^{i+1} c^{i+2} \middle| i \geq 1\right\}$. 6

c) Explain the following :

i) Halting problem

ii) Linear bounded automata

iii) Non self accepting

iv) Recursively enumerable language. 8

8. a) Explain the relationship among the difference class of language in Chomsky Hierarchy. Describe the context sensitive grammar with the help of example. 6

b) Show that if L_1 and L_2 are recursively enumerable languages over Σ then $L_1 \cup L_2$ and $L_1 \cap L_2$ are also recursively enumerable. 5

c) Construct the left linear and right linear grammars for the language : $L = \{a^n b^{m+1} | n \geq 2, m \geq 1\}$. 6

d) Discuss the Rice theorem. 3

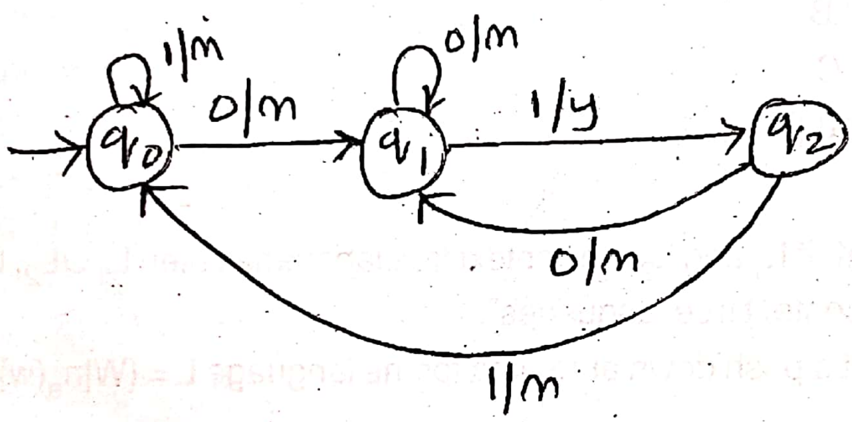
T.E. (Comp.) (Semester – V) (RC) Examination, Nov./Dec. 2016
AUTOMATA LANGUAGES AND COMPUTATION

Duration : 3 Hours Total Marks : 100

Instructions : *Assume data **wherever** required. Answer **any 5** questions with atleast **one** from **each** Module.*

MODULE – I

1. a) Convert the following mealy machine to an equivalent Moore machine. 6



b) State Kleen's Theorem. Prove Part – I of Kleen's Theorem. 6

c) Determine regular expressions for the following languages.

i) L = {W : |W| mod 3 = 0}

ii) L = $\{a^{2n} b^{2m+1} \mid n \geq 0, m \geq 0\}$. 4

d) State pumping lemma for regular languages. Prove that the language. L = $\{0^n | n$ is perfect square$\}$ is not regular. 4

2. a) Construct DFA for the following languages.

i) L = {W : |W| mod 5 ≠ 0} where Σ = {a, b}.

ii) L = $\{W (ab + ba) | W \in \{a, b\}^*\}$. 6

b) Construct mealy machine for binary adder. Convert this mealy machine to an equivalent Moore machine. 8

c) Construct a DFA to recognize the set of strings over Σ = {a, b}* that contain the same number of occurrences of the substring 'ab' as that of substring 'ba'. 6

P.T.O.

MODULE – II

3. a) Construct a top down push down automata for the following context free grammar.

   $S \rightarrow a \mid aS \mid bSS \mid SSb \mid SbS$

   Draw transition table and hence validate the string "abbaa". 8

   b) Design a context free grammar for the following language.

   $L = \{a^n b^m c^k \mid n + 2m = k \text{ for } n \geq 0, m \geq 0\}$ 6

   c) State and explain properties of context free languages. 6

4. a) What is Greibach Normal Form ? Convert the following context free grammar into Greibach Normal Form.

   $Q \rightarrow Aa \mid B$

   $B \rightarrow aa \mid C$

   $C \rightarrow a \mid bd \mid c$

   $A \rightarrow b.$ 8

   b) Prove that "If L_1 and L_2 are context free languages then $L_1 \cup L_2$, $L_1.L_2$ and L_1^* are also context free languages". 6

   c) Construct a push down automata for the language $L = \{W \mid n_a(w) > n_b(w)\}$. 6

MODULE – III

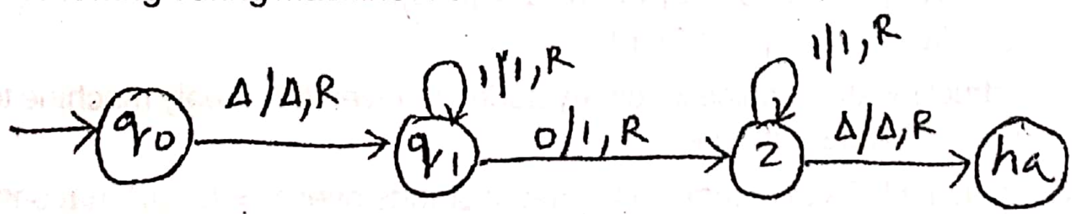
5. a) Write short note on variants on Turing machine. 6

   b) Design a Turing machine for the language

   $L = \{a^i b^j \mid i > j\}$ over $\Sigma = \{a, b\}$. 6

   c) Design a Turing machine that recognizes palindrome strings over $\Sigma = \{a, b\}^*$. 8

6. a) Explain universal Turing machine with all its encoding functions. Encode the following Turing machine 'T'. 10



   b) Design a Turing machine that accepts the language $L = \{a^n b^n c^n \mid n \geq 1\}$. 8

   c) State Church-Turing Thesis. 2

MODULE – IV

7. a) Write short notes on : 12

i) Recursively enumerable language

ii) Linear bounded automata

iii) Unrestricted grammar

iv) Context sensitive grammar.

b) Construct context sensitive grammar for the following language. 8

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

8. a) Write short notes on : 12

i) Full trio

ii) Rice theorem

iii) Halting problem

iv) Chomsky hierarchy.

b) Construct unrestricted grammar for the language 8

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

COMP 5 – 2 (RC)

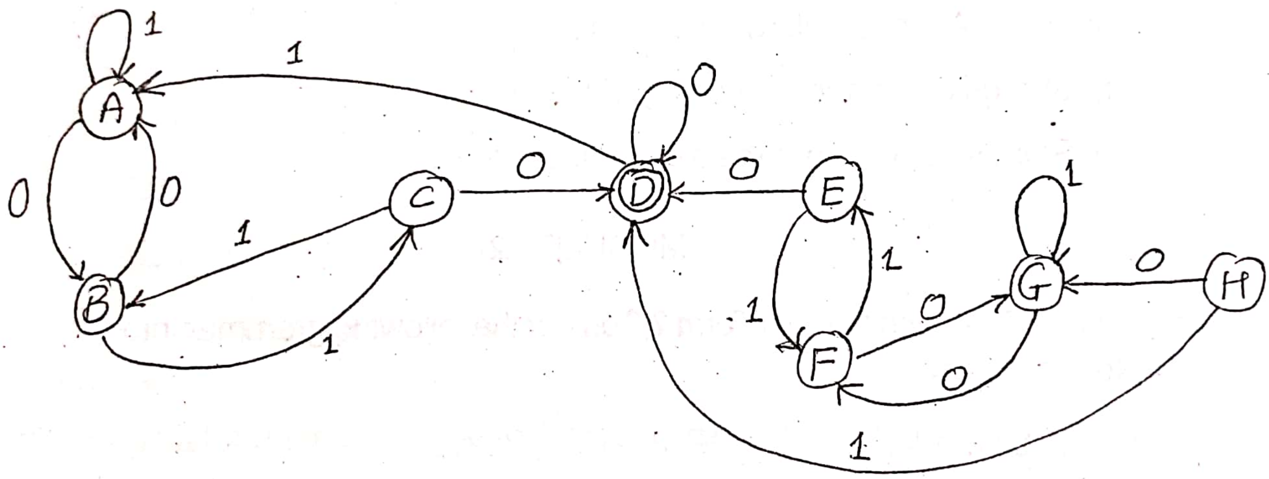
T.E. (Comp.) (Semester – V) (RC) Examination, May/June 2016
AUTOMATA LANGUAGES AND COMPUTATION

Duration : 3 Hours   Total Marks : 100

Instructions : ***Assume** data **wherever** required.*
*Answer **any 5** questions with atleast **one** from **each** Module.*

MODULE – 1

1. a) Minimize the following Deterministic Finite Automata using table filling algorithm. **10**



b) Determine Finite Automata for the following language :

$L = \{w \mid n_a(w) \geq 1 \text{ and } n_b(w) = 2 \text{ and } w \in \{a,b\}^*\}$. **6**

c) Explain extended transition function for NFA and hence determine $\delta^*(q_0, 0111)$ for the NFA $M = (\{q_0, q_1, q_2, q_3\}, \{0, 1\}, q_0, \{q_3\}, \delta)$.

Where $\delta(q_0, 0) = q_1, \delta(q_0, 1) = \{q_0, q_1\}, \delta(q_1, 0) = q_2$

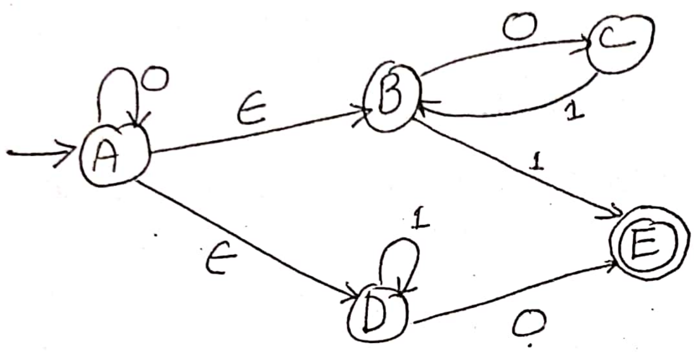
$\delta(q_1, 1) = q_2, \delta(q_3, 0) = \phi, \delta(q_3, 1) = \phi$. **4**

P.T.O.

2. a) State Pumping Lemma for regular languages and hence prove that the language $L = \{a^n b^n \mid n \geq 1\}$ is not context free language. 6

b) Determine a Mealy machine for binary adder. 4

c) Convert the following $\in$ – NFA to NFA. 6



d) Obtain DFA for the following strings :

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

ii) Strings beginning with ab or ending with ab.

MODULE – 2

3. a) What is Greibach Normal Form ? Convert the following grammar into Greibach Normal Form :

$$G = (\{A, S, B\}, \{a, b\}, S, P = \{S \to AB,\ A \to BS \mid b,\ BSA \mid a\}).$$

b) Determine Context Free Grammar (CFG) for the following languages :

i) $L = \{a^n b^n \mid n \geq 0\}$

ii) $L = \{a^i b^j c^k \mid i = j + k\}$.

c) Design Push Down Automata corresponding to the Context Free Grammar whose productions are as follows :

$S \to S + T$

$S \to T$

$T \to T * a$

$T \to a$.

4. a) Prove that the language :

   i) $L = \{ww \mid w \in \{a, b\}^*\}$ is not context free language.

   ii) $L = \{a^n b^m \mid n = m^2\}$ is not context free language. 6

   b) Construct Non Deterministic Push Down Automata (NPDA) for the language $L = \{a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i = j + k\}$ validate the string aaabbc. 8

   c) Prove that : "If L_1 and L_2 are context free languages then $L_1 \cup L_2$ and $L_1.L_2$ are also context free languages". 6

MODULE – 3

5. a) Design a Turing machine that computes the function f(x) = m – n where m and n are both positive integer numbers. If $m \leq n$ then it outputs 0. Assume Turing machine uses unary notation. 8

   b) Give encoding function for a Universal Turing Machine. 6

   c) Explain the following terms :

   i) Recursively Enumerable Language.

   ii) Multitape Turing Machine. 6

6. a) Design a turing machine that computes f(x) = n mod 2 where n is a positive number. 6

   b) Design a turing machine that accepts the following language $L = \{ww^R \mid w \in \{a, b\}^* \text{ and } |w| > 0\}$. 8

   c) Explain the variations of turing machine. 6

MODULE – 4

7. a) Explain the relationship among different classes of languages in Chomsky hierarchy. 4

   b) Construct a context sensitive grammar for the following language. $L = \{a^n b^n c^n \mid n \geq 1\}$ and validate the string aa bb cc. 6

   c) Prove that : If L_1 and L_2 are recursively enumerable languages over Σ then $L_1 \cup L_2$ is also recursively enumerable. 8

   d) Explain Generalized Sequential Machine. 2

8. a) Construct unrestricted grammar to generate {SS | S∈ {a, b}*}. 8

b) Explain the following terms :

i) Full Trio

ii) Linear Bounded Automata

iii) Rice Theorem. 12

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COMP 5 – 2 (RC)

TE (Comp.) (Semester – V) (RC) Examination, November/December 2015
AUTOMATA LANGUAGES & COMPUTATION

Duration : 3 Hours Total Marks : 100

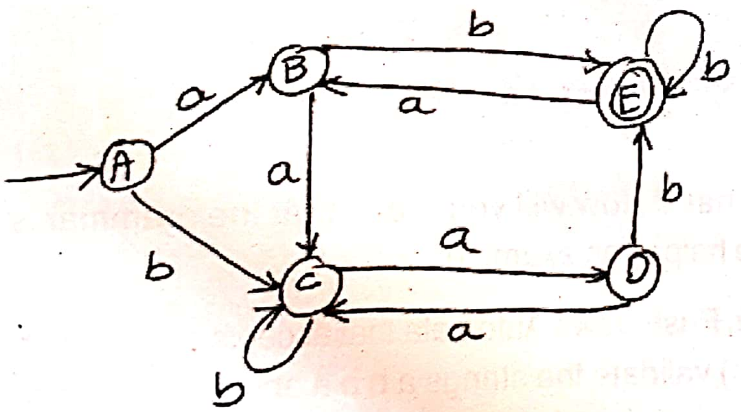
Instructions : *1) Assume data **wherever** required.*
*2) Answer **any 5** questions with atleast **one** from **each** Module.*

MODULE – I

1. a) State Kleens Theorem. Prove Part 1 of Kleens theorem 6

   b) Construct a Mealy Machine to add two binary numbers. Convert the resulting Mealy Machine to equivalent Moore machine. 8

   c) Minimize the following deterministic finite Automata using table filling algorithm. 6



2. a) Obtain regular expressions for the following languages :

   i) $L=\{a^n b^m | n \geq 4, m \leq 3\}$

   ii) $L = \{w | n_a(w) \bmod 3 = 0 \text{ and } w \in \{a,b\}^*\}$. 6

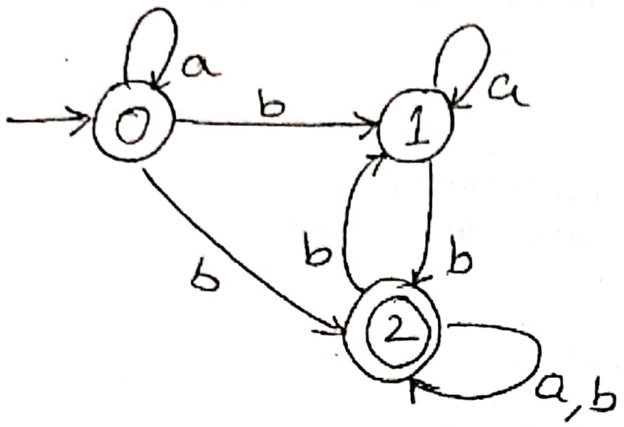
   b) Prove that the languages :

   i) $L=\{a^{n!} | n \geq 0\}$ is not regular

   ii) $L=\{w | n_a(w) < n_b(w) \text{ and } w \in \{a,b\}^*\}$ is not regular. 6

P.T.O.

c) Convert the following Non-deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA). 6



d) Explain Homomorphism using examples. 2

MODULE – II

3. a) Convert the given grammar to Grcibach Normal Form (GNF)

$S \rightarrow A B b/a$

$A \rightarrow a a A$

$B \rightarrow b A b.$ 6

b) What is ambiguous grammar ? How will you prove that the grammar is ambiguous ? Show with the help of an example. 6

c) Construct a non deterministic Push Down Automata that accepts all palindrome strings (odd as well as even) validate the strings a b b a and a b c b a for the same. 8

4. a) Design a Deterministic Push Down Automata (DPDA) to recognize the language $L=\left\{0^n 1^m 0^n \middle| n,m>0\right\}$ validate the string 00100. 6

b) State Pumping Lemma for context Free Languages. Prove that the language : $L=\left\{a^n b^{2n} c^n \middle| n\geq 0\right\}$ is not context free language. 4

c) Convert the following grammar into Grcibach Normal From (GNF) and hence draw a Push Down Automata (PDA) for the same.

$E \to E/E \mid E * E \mid T$

$T \to (E) \mid a$. 6

d) Construct context Free Grammar for the following language

$L = \{a^i b^j \mid i \geq 2j\}$. 4

MODULE – III

5. a) Design a Non Deterministic Turing Machine to accept numbers that are multiples of 2 or 3 in unary format. 4

b) Design a turing machine to compute the function f(x) = m × n where m and n are positive integers. Initially, the tape contains string $1^m 0 1^n 0$. 10

c) Write short notes on :

i) Non-Deterministic Turing Machine

ii) Church Turing Thesis. 6

6. a) Design and Encode a turing machine to find 1's complement of a given binary number. 8

b) Design a turing machine to accept the language

$L = \{w \in \{0,1\}^* \mid w \text{ ends with } 010\}$. 6

c) Write short notes on :

i) Multitape Multihead turing machine

ii) Recursively Enumerable language. 6

MODULE – IV

7. a) What are context sensitive Languages ? Determine Context Sensitive Grammar for language

$L = \{a^n b^n c^n \mid n \geq 1\}$. 8

b) Explain the following terms :

i) Linear Bounded Automata

ii) Rice Theorem. 6

c) Explain the equivalence of turing machine and type O grammar. 6

8. a) Explain the closure properties of families of languages. 6

b) Explain the following terms :

i) Chomsky Hierarchy

ii) Halting problem of turing machine. 6

c) Prove that : If L_1 and L_2 are recursively enumerable languages over Σ, then $L_1 \cup L_2$ is also recursively enumerable. 8

COMP 5 – 2 (RC)

TE (Comp.) (Semester – V) (RC) Examination, November/December 2015
AUTOMATA LANGUAGES & COMPUTATION

Duration : 3 Hours

Total Marks : 100

Instructions : 1) *Assume data* ***wherever*** *required.*

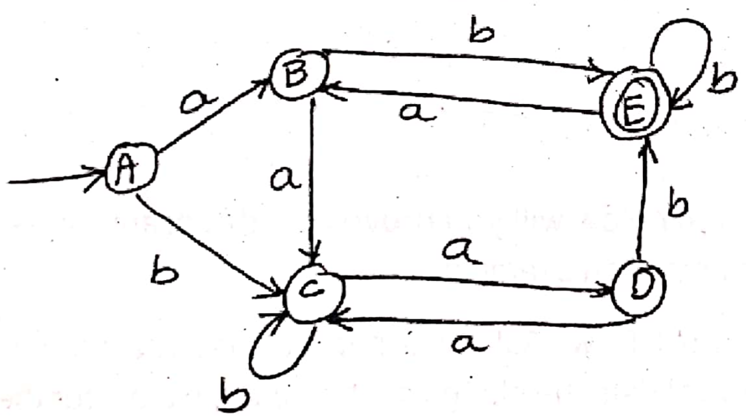
2) *Answer* ***any 5*** *questions with atleast* ***one*** *from* ***each*** *Module.*

MODULE – I

1. a) State Kleens Theorem. Prove Part 1 of Kleens theorem 6

b) Construct a Mealy Machine to add two binary numbers. Convert the resulting Mealy Machine to equivalent Moore machine. 8

c) Minimize the following deterministic finite Automata using table filling algorithm. 6



2. a) Obtain regular expressions for the following languages :

i) $L=\left\{a^n b^m \middle| n \geq 4, m \leq 3\right\}$

ii) $L=\{w \mid n_a(w) \bmod 3 = 0 \text{ and } w \in \{a,b\}^*\}$. 6

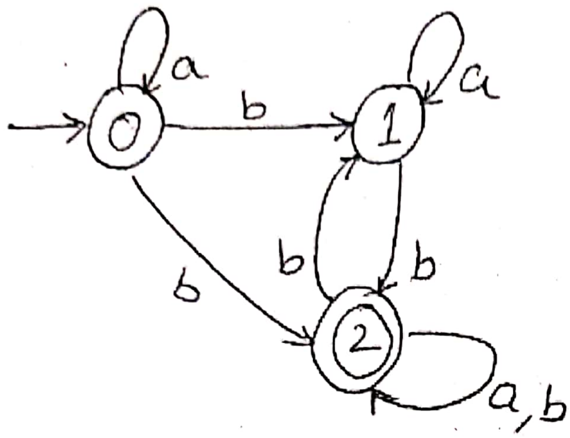
b) Prove that the languages :

i) $L=\left\{a^{n!} \middle| n \geq 0\right\}$ is not regular

ii) $L=\{w \mid n_a(w) < n_b(w) \text{ and } w \in \{a,b\}^*\}$ is not regular. 6

P.T.O.

c) Convert the following Non-deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA). 6



d) Explain Homomorphism using examples. 2

MODULE – II

3. a) Convert the given grammar to Grcibach Normal Form (GNF)

$S \rightarrow A\,B\,b/a$

$A \rightarrow a\,a\,A$

$B \rightarrow b\,A\,b.$

6

b) What is ambiguous grammar ? How will you prove that the grammar is ambiguous ? Show with the help of an example. 6

c) Construct a non deterministic Push Down Automata that accepts all palindrome strings (odd as well as even) validate the strings a b b a and a b c b a for the same. 8

4. a) Design a Deterministic Push Down Automata (DPDA) to recognize the language $L = \left\{ 0^n 1^m 0^n \middle| n, m > 0 \right\}$ validate the string 00100. 6

b) State Pumping Lemma for context Free Languages. Prove that the language : $L = \left\{ a^n b^{2n} c^n \middle| n \geq 0 \right\}$ is not context free language. 4

c) Convert the following grammar into Grcibach Normal From (GNF) and hence draw a Push Down Automata (PDA) for the same.

$E \rightarrow E/E \mid E * E \mid T$

$T \rightarrow (E) \mid a$. 6

d) Construct context Free Grammar for the following language

$L = \{ a^i b^j \mid i \geq 2j \}$. 4

MODULE – III

5. a) Design a Non Deterministic Turing Machine to accept numbers that are multiples of 2 or 3 in unary format. 4

b) Design a turing machine to compute the function $f(x) = m \times n$ where m and n are positive integers. Initially, the tape contains string $1^m 0 1^n 0$. 10

c) Write short notes on :

i) Non-Deterministic Turing Machine

ii) Church Turing Thesis. 6

6. a) Design and Encode a turing machine to find 1's complement of a given binary number. 8

b) Design a turing machine to accept the language

$L = \{ w \in \{0,1\}^* \mid w \text{ ends with } 010 \}$. 6

c) Write short notes on :

i) Multitape Multihead turing machine

ii) Recursively Enumerable language. 6

MODULE – IV

7. a) What are context sensitive Languages ? Determine Context Sensitive Grammar for language

$L = \{ a^n b^n c^n \mid n \geq 1 \}$. 8

b) Explain the following terms :

i) Linear Bounded Automata

ii) Rice Theorem. 6

c) Explain the equivalence of turing machine and type O grammar. 6

8. a) Explain the closure properties of families of languages. 6

b) Explain the following terms :

i) Chomsky Hierarchy

ii) Halting problem of turing machine. 6

c) Prove that : If L_1 and L_2 are recursively enumerable languages over Σ, then $L_1 \cup L_2$ is also recursively enumerable. 8

COMP 5 – 2 (RC)

6

6

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T.E. (Computer) (Semester – V) Examination, May/June 2015
(Revised Syllabus in 2007 – 2008)
AUTOMATA LANGUAGE AND COMPUTATION

Duration : 3 Hours | Total Marks : 100

Instructions : *1) Answer **any five** full questions, at least **one** from **each** Module.*
*2) Make suitable assumptions **wherever** necessary.*

MODULE – I

1. a) Convert the following ε-NFA into NFA without ε-transitions.

   M = ({A, B, C, D}, {0, 1}, {d(A, 0) = B, d (A, e) = C, d(C, 0) = C, d(C, 1) = C, d(C, 1) = D, d(B, 1) = D}, A, {D}). Convert NFA to DFA. Write the regular expression for the above constructed DFA. **8**

   b) Prove that the following language L over the alphabet {a, b, c} is not regular : L = {wcx | w,x ε {a, b}* and number of a's in w is equal to number of b's in x}. **6**

   c) Design a finite state machine that compares two binary numbers to determine whether they are equal and which of the two is smaller. Assume that the digit of the two numbers come in one by one with the lowered digit coming in first. **6**

2. a) Find the regular expression for the given DFA **6**

   M = ({q_0, q_1, q_2}, {0, 1}, δ, q_0, {q_2}), where δ is δ = {δ(q_0, 1) = q_2, δ(q_0, 0) = q_2, δ(q_2, 1) = q_1, δ(q_2, 0) = q_2, δ(q_1, 1) = q_0, δ(q_1, 0) = q_0}.

   b) Construct the DFA for the following languages **8**

   L_1 = {w | w has even number of b's}, L_2 = {w | each b is followed by atleast one a}

   Find the $L_1 \cap L_2$, $L_2 - L_1$ for the above two languages. Draw the minimized DFAs.

   c) Construct the NFA that recognizes the language **6**

   L = {x ε {a, b}* | (x contains(at least) two consecutive a's) and (x does not contain two consecutive b's)}.

P.T.O.

MODULE – II

3. a) Convert the following grammar to Chomsky Normal Form.

$G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow ASB|\varepsilon, A \rightarrow aAS|a, B \rightarrow SbS|A|bb\}, S)$

b) Construct the CFG for the following language

$L = \{0^i 1^j 2^k | i, j \geq 0 \text{ and } (i = 3j \text{ or } j = 3k)\}$

c) Construct the CFG for the given PDA $M = (\{A, B\}, \{a, b\}, \{Z, X\}, \delta, A, Z, \phi)$ where δ is defined as $\{\delta(A, b, Z) = (A, XZ), \delta(A, \varepsilon, Z) = (A, \varepsilon), \delta(A, b, X) = (A, XX), \delta(A, a, X) = (B, X), \delta(B, b, X) = (B, \varepsilon), \delta(B, a, Z) = (A, Z)\}$.

Give the corresponding leftmost Derivation for string : bbabb.

4. a) Is the following language context-free ? Justify your answer.

$L = \{a^m b^n c^p \mid m = n \text{ or } n = p \text{ or } m = p\}$.

b) Convert the CFG to GNF.

$G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow AB, A \rightarrow BS|b, B \rightarrow SA|a\}, S)$.

c) Convert CFG into PDA. Explain the behaviour of the PDA for the string abba.

G = ({S,A,B}, {a, b}, {S-->aB|bA, A-->a|aS|bAA, B-->b|bS|aBB},S). 8

d) Define deterministic pushdown automata. 2

MODULE – III

5. a) Construct a Turing machine that accepts the language $L = \{a^n b^{n-1} c^{n-2} \mid n > 2\}$. 6

b) Explain the following :

i) Nondeterministic Turing Machine

ii) Universal Turing Machine. 6

c) Construct the Turing machine that recognizes the following language 8

$L = \{a^i b^j c^k d^l \mid i + k = j + 1 \; i, j, k, l \geq 0\}$

6. a) Define a Turing Machine. Construct a Turing Machine that concatenates two strings over the alphabet {a, b}. 6

b) Explain the variants of Turing Machine. 4

c) Construct the Turing Machine(TM) that recognizes the following language $L = \{a^x \mid x = i^2, i \geq 1\}$ explain the behaviour of the TM with the help of a string aaaa. 10

MODULE – IV

7. a) Construct a right linear regular grammar for the following regular expression $re = ((10)^{+}(011 + 1)^{+})^{*}(0 + 101)^{*}$. Convert right linear grammar to left linear grammar. 8

b) Explain the following. 6

i) AFL

ii) Non self accepting

iii) Trio.

c) Prove that language L is recursive iff both L and complement of L is also recursive. 6

8. a) Construct the type 0 grammar for the following language. 6

$L = \{a^i b^j c^k d^l \mid i + k = j + 1 \; i, j, k, l \geq 0\}$

Validate the string aabcdd.

b) Explain the following : 6

i) Unsolvable Decision problems

ii) Recursively enumerable languages.

c) Find the context-sensitive grammar for the language $L(G) = \{a^n b^n a^{2n} \mid n \geq 1\}$. Using the CSG draw the parse tree for the string aabbaaaa. 6

d) Construct type 3 grammar for the language $L(G) = \{a^{2n} \mid n \geq 1\}$. 2

T.E. (Computer) (Semester – V) Examination, Nov./Dec. 2014
(Revised Syllabus in 2007-08)
AUTOMATA LANGUAGES AND COMPUTATION

Duration : 3 Hours Total Marks : 100

Instructions : *1) Answer **any five full** questions, at least **one** from **each** Module.*
*2) Make **suitable** assumptions **wherever** necessary.*

MODULE – I

1. a) Construct a DFA to recognize the set of strings over {a, b}* that contain the same number of occurrences of the substring ab as of the substring ba. 6

b) Minimize the following DFA using table filling method. 6

$M = (\{1, 2, 3, 4, 5, 6\}, \{a, b, c\}, \delta, 1, \{2, 4, 5, 6\})$ where δ is $\delta = \{\delta(1, a) = 5,$

$\delta(1, b) = 2,\ \delta(1, c) = 2, \delta(2, a) = 1, \delta(2, b) = 6,\ \delta(2, c) = 2, \delta(3, a) = 2, \delta(3, b) = 4,$

$\delta(3, c) = 5, \delta(4, a) = 3,\ \delta(4, b) = 6\ \delta(4, c) = 2, \delta(5, a) = 3, \delta(5, b) = 6,$

$\delta(5, c) = 5, \delta(6, a) = 1, \delta(6, b) = 3,\ \delta(6, c) = 4\}.$

c) Construct a Mealy Machine to add two binary numbers. Convert the Mealy Machine to equivalent Moore Machine. 8

2. a) Prove the following languages (all with input alphabet {0, 1}) are regular or not. 8

a) Non-empty strings with the last symbol equal the first symbol.

b) Odd-length strings with the first symbol equal the middle symbol.

b) Construct a regular expression to represent the following DFA $M = (\{A, B, C, D\}, \{0, 1\}, \delta, A, \{B, D\})$ where δ is defined as 8

State	Input 0	Input 1
A	C	B
B	D	A
C	B	C
D	A	C

c) Construct a NFA that accepts the language $L = \{a\ \varepsilon \{0,1\}^* \mid\mid a \mid$ is a multiple of 2 or 3}. 4

P.T.O.

MODULE – II

3. a) Let $\Sigma = \{0,1\}$. Consider the language NEP defined as follows :

NEP = $\{w \in \Sigma^* \mid w$ is not an even-length palindrome$\}$ Construct the CFG. Convert the CFG to PDA.

b) Prove the given language is not CFL.

$L = \{ww \mid w \in \{a,b\}^*\}$

c) Construct NPDA for the following language over alphabet Σ.

$L = \{w_1cw_2 \mid w_1, w_2 \in \{a,b\}^*$ and $w_1 \neq w_2^R\}$. $\Sigma = \{a,b,c\}$.

4. a) Construct Top-down PDA for given CFG

$G = (\{S\},\{a,b\},\{S \rightarrow a \mid aS \mid bSS \mid SSb \mid SbS\},S)$. Show the sequence of moves for input string : abbaaa. 8

b) Construct the grammar in GNF for the given language

$L = \{a^kb^mc^n \mid k,m,n,\ 2k \geq n\}$ 8

c) Show that context free languages are closed under

i) Union

ii) Kleene closure. 4

MODULE – III

5. a) Given an input #w#, where w is a string of a's and b's construct a Turing machine makes a copy of w and halts with #w#w# as the output. 6

b) Explain the following :

i) Church-Turing Thesis

ii) Non-deterministic Turing Machine. 4

c) Discuss the power of Turing machine. Construct a TM to divide two positive integers. Assume that the numbers are represented as a unary string of 1's. 10

6. a) Explain the Universal Turing machine. 6

b) Construct a TM that insert σ such that the tape contents are changed from yz to $y\sigma z$ where $y \in (\Sigma \cup \{\Delta\})^*$, $\sigma \in (\Sigma \cup \{\Delta\})$, $z \in \Sigma^*$, $\Sigma = \{a,b\}$. 8

c) Design the Turing machine for the following language :
$L = \{|x|_0 \text{ mod } 2 \text{ and } |x|_1 \equiv 0 \text{ mod } 2 | x \in \{0, 1\}^*\}$. 6

MODULE – IV

7. a) Construct the type 0 grammar that generates the language $L = \{ww \mid w \in \{0, 1\}+\}$. Show the right most derivation for the string abab. (6+2)

b) Explain the following :

i) Trios and Full Trios

ii) Generalized sequential machine

iii) AFL. 6

c) Explain the equivalence of Context Sensitive grammar and Linear Bounded Automaton. 6

8. a) Construct the CSG for the following language.
$L = \{a^i b^i c^i d^{2i} \mid i > 0\}$. Validate the given string abcdd. 6

b) Explain the equivalence of Turing Machine and Type 0 grammar. 6

c) Construct the left linear grammar for the given regular expression $(10 + (0 + 11)0^*1)^*$. Convert left linear grammar to right linear grammar. 8

COMP 5 – 2 (RC)

T.E. (Computer) (Semester – V) Examination, May/June 2014
(Revised Syllabus)
AUTOMATA LANGUAGE AND COMPUTATION

Duration : 3 Hours

Total Marks : 100

Instructions: 1) *Answer* ***any five full*** *questions, at least* ***one*** *from* ***each*** *Module.*

2) ***Make*** *suitable assumptions* ***wherever*** *necessary.*

MODULE – I

1. a) Construct the DFA M over $\Sigma = \{0, 1\}$ which accepts the word from Σ such that, the number of 0's are even and the number of 1's are not divisible by three. Verify if the string 1010 is acceptable by the above DFA. **6**

b) Prove that the RL's are closed under the following : **4**

i) Intersection ii) Complement

c) Find the regular expression for the given DFA. **6**

$M = (\{q_0, q_1, q_2\}, \{0, 1\}, \delta, q_0, \{q_0\})$, where δ is $\delta = \{\delta(q_0, 1) = q_1, \delta(q_0, 0) = q_0, \delta(q_1, 1) = q_1, \delta(q_1, 0) = q_2, \delta(q_2, 1) = q_1, \delta(q_2, 0) = q_0\}$.

d) Construct the Moore Machine to subtract given two binary numbers. **4**

2. a) Construct the NFA that recognizes the language given as follows : $L(M) = \{x \varepsilon \{a, b\}^* \mid$ x contains at the most one pair of consecutive 0's and at the most one pair of consecutive 1's$\}$. **4**

b) Construct the ε-NFA for the regular expression $01 + (0^? 1^+)^*$. Convert the ε-NFA to minimized DFA. **8**

c) Prove that the language $L(M) = (ww^r \mid w \varepsilon \{a, b\}^*\}$ is not regular language. **4**

d) Write the regular expression for the following languages. **4**

i) $L(M) = \{x \varepsilon \{a,b\}^* \mid$ x contains at the most one pair of consecutive 0's and at the most one pair of consecutive 1's$\}$.

ii) $L(M) = \{x \varepsilon \{0, 1\}^* \mid |x|_0 \bmod 2$ and $|x|_1 \equiv 0 \bmod 2\}$.

P.T.O.

MODULE – II

3. a) Construct the CFG for the following :
   $L(G) = \{a^i b^j c^k \mid i = j + k, j, k \geq 1\}$. Validate the string aaabbc. 5

   b) Construct the PDA for the language $L(M) = \{a^n b^m \mid n \neq m\}$. Explain the behavior of the pushdown automata with the help of a string. 5

   c) Construct the CFG for the given PDA $M = (\{A, B\}, \{a, b\}, \{Z, X\}, \delta, A, Z, \phi)$ where δ is defined as $\{\delta(A, a, Z) = (A, XZ), \delta(A, a, X) = (A, XX)$,
   $\delta(A, b, X) = (B, X), \delta(B, b, X) = (B, X), \delta(B, a, X) = (B, \varepsilon)$,
   $\delta(B, \varepsilon, Z) = (B, \varepsilon)\}$. 6

   d) Prove that the language $L(M) = \{a^{2n} b^n c^n \mid n \geq 1\}$ is not a CFL. 4

4. a) Convert the given CFG $G = (\{S,A,B\}, \{a, b\}, \{S \to Ab|Ba, A \to aS|bAA|a, B \to bS|bBB|b\}, S)$ to PDA. 5

   b) Convert the CFG $G = (\{S, A\}, \{c\} \{S \to ASc, S \to Ab, A \to SA, A \to c\}, S)$ to GNF. 5

   c) Prove that the CFL's are closed under kleene closure and are not closed under intersection and complement. 6

   d) Convert the given CFG $G = (\{S, A\}, \{c\} \{S \to ASc, S \to Ab, A \to SA, A \to c|\varepsilon\}, S)$ to CNF. 4

MODULE – III

5. a) Construct the Turing Machine to compute the quotient and reminder when i is divided by j. Given input as $\# a^i \# b^j \#$ and output as $\# a^i \# b^j \# c^k \# d^l \#$ where k is the quotient when i is divided by j and l is the reminder. 12

   b) Construct the Turing Machine which recognizes the language consisting of all strings of 0s whose length is a power of 2. 8

6. a) Construct the Turing Machine that recognizes the language $L(M) = \{a^{2n}b^{n}c^{2n} | n \geq 0\}$. 4

b) Construct the Turing Machine which computes $f(m, n) = 2m \times 3n$. Explain the behavior of the Turing Machine with the help of a string. 10

c) Explain the variants of Turing Machine. 6

MODULE – IV

7. a) Construct the grammar that generates the language $L(G) = \{a^{i} |$ i is the power of 2$\}$. State the type of grammar generated for the above grammar. Validate the string aaaa. 6

b) Describe the language set L(G), for each of the following grammars. 4

i) $G = (\{S, X\}, \{0, 1\} \{S \rightarrow 0X | 1X, X \rightarrow 1X | 1\}, S)$.

ii) $G = (\{S, X, Y, Z\}, \{0\}, \{S \rightarrow 0X | \lambda, X \rightarrow 0Y, Y \rightarrow 0Z | 0, Z \rightarrow 0Y\}, S)$.

c) Explain the closure properties of families of languages. 6

d) Explain the equivalence of Regular Grammar and Finite Automaton. 4

8. a) Explain the equivalence of Context Sensitive Grammar and Linear Bounded Automaton. 4

b) Construct the left linear and right linear grammar for the r.e (10+01)*10*1(1+0)*.Show the derivation tree for the string to validate each of the above grammars. 8

c) Construct the grammar that generates the language $L = \{a^{n+2} b^{n+1} c^{n} | n \geq 1\}$. State the type of grammar generated for the above grammar. 4

d) Explain Trios and Halting problem. 4

COMP 5 – 2 (RC)

T.E. (Computer) (Semester – V) Examination, Nov./Dec. 2013
(Revised Course)
AUTOMATA LANGUAGE AND COMPUTATION

Duration : 3 Hours

Total Marks : 100

Instructions : *1) Answer **any five full** questions, at least **one** from each Module.*

*2) **Make** suitable assumptions **wherever** necessary.*

MODULE – I

1. a) Construct the DFA for the following language : 8

$L(M) = \{w \varepsilon \{a,b\}^* \mid$ w contains baba or doesn't contain ab $\}$.

b) Construct the regular expression for the given DFA M = ({A, B, C}, {0, 1} δ, A, {B, C} where δ is defined as $\{\delta(A, 0) = B, \delta(A, 1) = C, \delta(B, 0) = A, \delta(B, 1) = C, \delta(C, 0) = B, \delta(C, 1) = B\}$. 8

c) Prove that the language $L(M) = \{0^m1^n \mid m \neq n\}$ is not regular language. 4

2. a) Construct the NFA for the language $L(M) = \{x \varepsilon \{a, b\}^* \mid x$ contains a substring bb or bab}. Draw the computation tree for the string bbab. 4

b) Construct the ε – NFA which accepts L(r) where $r = (0 + 11)^* (10^* + \varepsilon)$. Convert the constructed ε – NFA to NFA. 3

c) Minimize the following DFA using table filling method : 6

M = ({A, B, C, D, E, F, G, H), {a, b}, δ, A, {C}) where δ is $\delta = \{\delta(A, a) = F, \delta(A, b) = B, \delta(B, a) = C, \delta(B, b) = G, \delta(C, a) = C, \delta(C, b) = A, \delta(D, a) = G, \delta(D, b) = C, \delta(E, a) = F, \delta(E, b) = H, \delta(F, a) = G, \delta(F, b) = C, \delta(G, a) = E, \delta(G, b) = G, \delta(H, a) = C, \delta(H, b) = G\}$.

d) Construct the Mealy Machine to convert each occurrence of substring 100 by 101. Convert the Mealy Machine to equivalent Moore Machine. 7

P.T.O.

MODULE – II

3. a) Construct the CFG for the language $L(G) = \{0^i1^j2^k \mid k \leq i \text{ or } k \leq j\}$. Convert the constructed CFG to CNF.

b) Prove that the CFL's are not closed under :

i) Intersection

ii) Complement.

c) Construct the PDA for the language $L(M) = \{0^n1^m2^{2m} \mid n, m \geq 0\}$.

d) Show that the language $L(M) = \{a^ib^jc^k \mid i = j = k \text{ and } i, j, k \geq 1\}$ is not CFL.

4. a) Define Instantaneous Description in a PDA. Construct the bottom-up PDA for the given CFG $G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow AB \mid \varepsilon, A \rightarrow aaA \mid \varepsilon, B \rightarrow bB \mid \varepsilon\}, S)$. Validate the string aaaab. 8

b) Construct the CFG for the given PDA $M = (\{A, B\}, \{a, b\}, \{Z, X\}, \delta, A, Z, \phi)$ where δ is defined as $\{\delta(A, b, Z) = (A, XZ), \delta(A, \varepsilon, Z) = (A, \varepsilon)\ \delta(A, b, X) = (A, XX), \delta(A, a, X) = (B, X), \delta(B, b, X) = (B, \varepsilon), \delta(B, a, Z) = (A, Z)\}$. 6

c) Define Greibach Normal Form. Convert the following grammar to GNF 6

$$G = (\{E, T, F\}, \{+, *, (,), a\}, \{E \rightarrow E + T \mid T, T \rightarrow T * F \mid F, F \rightarrow (E) \mid a\}, E).$$

MODULE – III

5. a) Construct the Turing Machine which can find out the value of $\log_2^n$ where n is stored as an unary number. 10

b) Explain the following : 10

i) Nondeterministic Turing Machine

ii) Universal Turing Machine.

6. a) Construct the Turing Machine to compute the function $f(w) = ww$. 8

b) Explain briefly the Church-Turing thesis. 2

c) Discuss the power of Turing machine. Construct the Turing machine to compute the addition of two given binary numbers. If the input on the tape is .. B10+01B.., then the output on the tape should be ..BB11B... 10

MODULE – IV

7. a) If L_1 and L_2 are recursively enumerable languages over Σ then $L_1 \cup L_2$ and $L_1 \cap L_2$ are also recursively enumerable. 4

b) Construct the unrestricted grammar for the following language : 4

$L(G) = \{a^n b^n c^n d^n \mid n \geq 1\}$.

c) Define the following : 4

i) Non self accepting

ii) Trio.

d) Construct the Right Linear Grammar for the language $L(G) = \{a^n b \mid n \geq 0\} \cup \{b^n a \mid n \geq 1\}$. Convert the Right Linear Grammar to Left Linear Grammar. 8

8. a) Consider the Unrestricted Grammar with productions : 8

$S \rightarrow aBS \mid \varepsilon$, $aB \rightarrow Ba$, $Ba \rightarrow aB$, $B \rightarrow b$. Simulate the TM.

b) Explain the equivalence of Context Sensitive Grammar and Linear Bounded Automation. 4

c) Construct the context-sensitive grammar for the following language : 4

$L(G) = \{a^n b^n a^{2n} \mid n \geq 1\}$.

d) Explain the following : 4

i) Halting problem

ii) Linear Bounded Automation.

T.E. (Computer) (Semester – V) (RC) Examination, May/June 2013
AUTOMATA LANGUAGE AND COMPUTATION

Duration: 3 Hours   Total Marks: 100

Instructions : *1) Answer **any five full** questions, at least **one** from **each** Module.*

*2) Make suitable assumptions **wherever** necessary.*

MODULE – I

1. a) Obtain the equivalent DFA for the following ε-NFA. **8**

   $M = (\{A, B, C, D, E\}, \{a, b\} \cup \varepsilon, \delta, A, \{E\})$ where $\delta = \{\delta(A, \varepsilon) = B, \delta(A, b) = C, \delta(B, \varepsilon) = D, \delta(B, \varepsilon) = C, \delta(B, a) = E, \delta(B, a) = A, \delta(C, b) = E, \delta(D, \varepsilon) = D, \delta(D, a) = E\}$

   b) Give the regular expressions for the following languages : **4**

   i) $L = \left\{a^n b^m \,\middle|\, n + m \text{ is odd}\right\}$

   ii) $L = \left\{a^n b^m \,\middle|\, n, m \geq 1, nm \geq 3\right\}$

   c) Design a Moore Machine that compares two binary numbers to determine whether they are equal and which of the two is larger. Convert the Moore Machine to equivalent Mealy Machine. **8**

2. a) Construct a regular expression to represent the following DFA **8**

   $M = (\{A, B, C, D\}, \{0, 1\}, \delta, A, \{B, D\})$ where $\delta = \{\delta(A, 0) = C, \delta(A, 1) = B, \delta(B, 0) = D, \delta(B, 1) = A, \delta(C, 0) = B, \delta(C, 1) = C, \delta(D, 0) = A, \delta(D, 1) = C\}$

   b) Construct the FAs for the following languages

   $L_1 = \{w \bmod 4 \mid w \,\varepsilon\, \{0, 1\}^*\}$ $L_2 = \{w \text{ contains substring } 100 \mid w \,\varepsilon\, \{0, 1\}^*\}$

   Draw FAs recognizing the languages $L_1 - L_2$, $L_1 \cap L_2$. **8**

   c) Prove that the language $L = \{a^n b^n \mid n \geq 1\}$ is not regular language. **4**

MODULE – II

3. a) Construct the CFG for the given language (3x

$L = \{0^n 1^m \mid 2^n \le m \le 3^n\}$.

Convert the CFG to CNF. Convert the CFG to PDA. Explain the behavior the PDA with the help of a string.

b) Construct the PDA for the given language

$L = \{w \mid w \in \{0, 1\}^*, n_0(w) \bmod 3 > n_1(w) \bmod 3\}$.

c) Simplify the following CFG

$G = (\{S, A, B, C\}, \{a, b\}, P = \{S \to aA\ bB \mid AC \mid BC \mid \varepsilon, A \to aA \mid B \mid \varepsilon, B \to Bb \mid \varepsilon, C \to CA \mid CB\}, S\}$.

4. a) Let L be the language over the alphabet {a, b} which consists of strings with twice as many a's as b's :

$L = \{x \in \{a, b\}^* \mid |x|_a = 2|x|_b\}$. Show that L is not context-free grammar. 5

b) Define GNF. Convert the CFG to GNF. (1+4)

$G = (\{S, X, Y\}, (0, 1\}, P = \{S \to SS \mid XY, X \to XX \mid 1X \mid \varepsilon, Y \to YY \mid 0Y \mid \varepsilon\}, S)$.

c) Construct the PDA for the given language (4+5+1)

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

Convert the PDA to CFG. Validate the given string aabbbb.

MODULE – III

5. a) Design a Turing Machine to compute the function $f(n) = \log_3 n$. Explain the behavior of the Turing Machine with the help of a string. 10

b) Explain the universal Turing Machine. 5

c) Design a Turing Machine which works as coping machine for $w \in \{a, b\}^+$. 5

6. a) Discuss the power of Turing Machine. Design a Turing Machine to compute the quotient and reminder when i is divided by j. Given input as $\#a^i\#b^j\#$ and output as $\#a^i\#b^j\#c^k\#d^l$ where k is the quotient when i is divided by j and l is the reminder. 10

b) Design a Turing Machine for the language $L = \{a^n b^n a^{2n} \mid n \ge 1\}$. 5

c) Explain briefly the variants of Turing Machine. 5

MODULE – IV

7. a) If L1 and L2 are recursively enumerable languages over Σ, then are $L1 \cap L2$ and $L1 \cup L2$ also recursively enumerable ? Justify your answer. 5

b) Construct the CSG for the following language 6

$L = \{a^i b^i c^i d^{2i} \mid i > 0\}$. Validate the given string abcdd.

c) Explain the following : (3+2)

i) AFL

ii) Rice theorem.

d) Construct the right linear grammar for the following language 4

$L = \{w \in \{0, 1\}^* \mid |w|_0 \text{ and } |w|_1 \text{ are even}\}$

8. a) Explain the generalized sequential machine. 4

b) Construct the type 0 grammar for the following language 6

$L = \{ww \mid w \in \{0, 1\}^*\}$. Validate the given string aabaab.

c) Explain the following : 4

i) Trios

ii) Halting problem.

d) Construct the left linear grammar for the following language 6

$L = \{a^n b^m \mid n \geq 2, m \geq 1\}$.

COMP – 5-2 (RC)

T.E. (Computer) (Semester – V) Examination, Nov./Dec. 2012
(Revised Syllabus in 2007-2008)
AUTOMATA LANGUAGE AND COMPUTATION

Duration : 3 Hours Max. Marks : 100

Instructions : *1) Answer* ***any five*** *full questions, atleast* ***one*** *from* ***each*** *Module.*
2) Make ***suitable*** *assumptions* ***wherever*** *necessary.*

MODULE – I

1. a) Construct a DFA for the following language

$L = \{x \varepsilon \{a, b\}^* \mid x$ has neither consecutive a's nor consecutive b's$\}$. **4**

b) Convert the following ε-NFA to minimized DFA

$M = (\{A, B, C, D\}, \{a, b, c\}, \delta A, \{A\})$ where δ is $\delta = \{\delta(A, a) = B, \delta(B, b) = C, \delta(B, \varepsilon) = A, \delta(C, c) = D, \delta(D, \varepsilon) = B\}$. **4**

c) What are the equivalence classes of R_L in Myhill-Nerode theorem for $L = \{0^n 1^n \mid n \geq 1\}$? **4**

d) Construct a Mealy Machine to subtract two binary numbers. Convert the Mealy Machine to equivalent Moore Machine. **8**

2. a) Construct a NFA which accepts set of strings such that every string contains '00' as a substring and does not contain '000' as a substring. Validate the string 100100. **(4+2)**

b) Is the following language a regular language ? Prove your answer.

$L = \{0^m 1^n 0^{n+m} \mid n \geq 1$ and $m \geq 1\}$. **5**

c) Let h be the homomorphism h(a) = 01, h(b) = 0

Find $h^{-1}(L_1)$ where $L_1 = (10 + 1)^*$

Find $h(L_2)$ where $L_2 = (a+b)^*$. **4**

d) Construct the regular expression for the following DFA

$M = (\{A, B, C\}, \{0, 1\}, \delta, A, \{B, C\}$ where $\delta = \{\delta(A, 0) = B, \delta(A, 1) = C, \delta(B, 0) = A, \delta(B, 1) = C, \delta(C, 0) = B, \delta(C, 1) = A\}$. **5**

P.T.O.

MODULE – II

3. a) Construct a CFG to generate PDA where M = ({p, q}, {0, 1}, {X, Z_0}, δ, q, Z_0, where δ is defined as δ (q, 1, Z_0) = (q, XZ_0), δ (q, 1, X) = (q, XX), δ (q, 0, X) = (p, δ (q, ε Z_0) = (q, ε), δ (q, 1, X) = (p, ε), δ (q, 0, Z_0) = (q, Z_0). Validate the strin 11010.

b) Convert the following language into CNF. Convert the CNF to PDA using bottom up approach.

L = {w | w ε {a, b}*, |w| is divisible by 3}.

c) Let L = {0^n1^m|n$\neq$m, n, m$\geq$1}. Construct a DPDA that recognizes L.

4. a) Prove that the language L = {a^n b^n c^j |n $\leq$ j $\leq$ 2^n} is not a CFL.

b) Convert CFG into PDA

G = ({S, A, B}, {a, b}, P = {S $\rightarrow$aB|bA, A$\rightarrow$a|aS|bAA, B$\rightarrow$b|b S|aBB}, S).
Explain the behavior of the PDA with the help of a string bbaaba. (3+2

c) Define the GN form of CFG and reduce the following grammar into GNF

G = ({S, A, B}, {a, b}, P = {S $\rightarrow$AB, A$\rightarrow$BS|b, B $\rightarrow$ SA|a}, S). 5

d) Construct the CFG for the following language

L = {$a^ib^jc^k$| i$\neq$j or i$\neq$k}. Validate the given string aabbbc. 5

MODULE – III

5. a) Construct the Turing machine that recognizes the following language L = {a^n b^n c^j | n $\leq$ j $\leq$ 2^n}. 6

b) Design the Turing Machine to compute n! where n$\geq$1. 8

c) Explain the variants of Turing Machine. 6

6. a) Design the Turing Machine that computes the sum of two binary numbers. 8

b) Construct the Turing machine that recognizes the following language L ={a^x| x = i^2, i $\geq$ 1}. 6

c) Explain the following :

i) Church-Turing Thesis

ii) Nondeterministic Turing Machine. 6

a) Constru Validat

b) Prove union

c) Exp i)

8. a) Pr

b) C

c)

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MODULE – IV

a) Construct the type 1 grammar for the language $\{a^i \mid i \text{ is a positive power of } 2\}$. Validate the given string aaaa. 8

b) Prove that the class of recursively enumerable languages are closed under union operation. 6

c) Explain the following : 6

i) Rice Theorem ii) Full Trio

8. a) Prove that language L is recursive iff both L and complement of L is also recursive. 6

b) Construct the type 0 grammar for the language $L = \{a^n b^m c^{n+m} d^{n-m} \mid n, m \geq 1\}$. Validate the given string aabcccd. 8

c) Explain the following :

i) Unsolvable decision problem

ii) Full AFL. 6

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COMP 5 – 2 (RC)

T.E. (Computer) (Semester – V) Examination, May/June 2012
(Revised Course)
AUTOMATA LANGUAGE AND COMPUTATION

Duration : 3 Hours Max. Marks : 100

Instructions : *1) Answer **any five** questions, selecting at least **one** from **each Module**.*
*2) Make **necessary** assumptions if **required**.*

MODULE – I

1. a) Design the deterministic finite automation for the following language :
$L = \{|x|_0 \bmod 2 \text{ and } |x|_1 \equiv 0 \bmod 2 \mid x \in \{0, 1\}^*\}$. 8

b) Prove the language $L(G) = \{ww \mid w \in \{0, 1\}^*\}$ is not regular. 6

c) Construct a NFA for the language $L(G) = \{x \in \{01\}^* \mid x$ is starting with 1 and $|x|$ is divisible by 3$\}$. Validate the string 1001110. 6

2. a) Construct a finite state machine that will subtract 2 binary numbers. 6

b) Using the Kleen's Part 2 theorem find the regular expression for the DFA
$M = (\{1, 2, 3\}, \{a, b\}, \delta, 1, \{2, 3\})$ where δ is defined as
$\delta(1, a) = 2$, $\delta(1, b) = 3$, $\delta(2, a) = 1$, $\delta(2, b) = 3$, $\delta(3, a) = 2$, $\delta(3, b) = 2$. 6

c) Construct the DFA for the following languages
$L_1 = \{w \mid w$ has odd number of b's$\}$, $L_2 = \{w \mid$ each b is followed by atleast one a $\}$.
Find the $L_1 \cap L_2$, $L_2 - L_1$ for the above two languages. Draw the minimized DFAs. 8

MODULE – II

3. a) Show that $L(G) = \{w \# t \mid w$ is a substring of t where $w, t \in \{a, b\}^*\}$ is not context-free. 6

b) Construct the CFG for the languages
$L = \{a^n b^m c^o d^p \mid n + m = o + p\}$. Convert the CFG to CNF. (4+4)

c) Construct a PDA that accepts the same language generated by the CFG
$G = (\{S, X\}, \{a, b\}, P, S)$ where $P = \{S \to XaaX, X \to aX \mid bX \mid \varepsilon\}$. Explain the behaviour the PDA with the help of the string aaab. 6

P.T.O.

4. a) Design the pushdown automata that accepts set of strings composed of zeros and ones which are of the form $0^n 1^n$ or $0^n 12^n$. 4

b) Construct the GNF for the following CFG

$S \to S \wedge S, S \to (S), S \to S \vee S, S \to \neg S, S \to p$ 6

c) Construct a CFG which accepts the PDA where

$M = (\{1, 2\}, \{a, b\}, \{B, X\}, \delta, 1, B, \phi)$ δ is given by

$\delta(1, b, B) = (1, XB)$, $\delta(1, \varepsilon, B) = (1, \varepsilon)$, $\delta(1, b, X) = (1, XX)$, $\delta(1, a, X) = (2, X)$ $\delta(2, b, X) = (2, \varepsilon)$, $\delta(2, a, B) = (1, B)$. 10

MODULE – III

5. a) Design a Turing machine which computes 2^n given n as input, where n is non-negative integer. Describe the behaviour of the TM for n = 3. 10

b) Discuss the power of Turing machine. Construct a TM that insert σ such that the tape contents are changed from yz to y σ z where $y \in (\Sigma \cup \{\Delta\})^*$, $\sigma \in (\Sigma \cup \{\Delta\})$, $z \in \Sigma^*$, $\Sigma = \{a, b\}$. 10

6. a) Design a TM to compute the minimum of two given unary numbers. 6

b) Explain the description of a multitape Turing machine for computing factorial of a given non-negative integer. 8

c) Explain the variants of Turing Machine. 6

MODULE – IV

7. a) Show that recursively enumerable languages are closed under intersection. 6

b) Explain the equivalence of LBA's and CSG's. 6

c) Construct type 0 for the language $L = \{0^n 1^n 2^n 3^n \mid n > 0\}$. 6

d) Construct type 3 grammar for the language $L(G) = \{a^{2n} \mid n \geq 1\}$. 2

8. a) State the properties of recursively enumerable languages. 2

b) Construct the type 1 grammar that generates the language $L = \{ww \mid w \in \{0, 1\}^+\}$. Show the right most derivation for the string abab. (6+2)

c) Explain the following : (4+6)

i) Rice Theorem

ii) Closure properties of families of languages.

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of Questions : 8] COMP 5-2 (RC)

T.E. (COMP.) (Semester - V) (RC) Examination, Nov. / Dec. - 2011

AUTOMATA LANGUAGES & COMPUTATION

ration : 3 Hours

Total Marks : 100

structions : *1) Answer any five questions and at least one from each Module.*

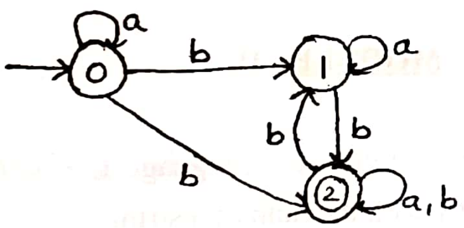
2) Make suitable asssumptions wherever necessary.

MODULE - I

Q1) a) State Mathematical Induction. Prove the following using Mathematical Induction

$$\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$$ [6]

b) Convert the following Non Deterministics Finite Automata to Deterministics Finite Automata. [6]

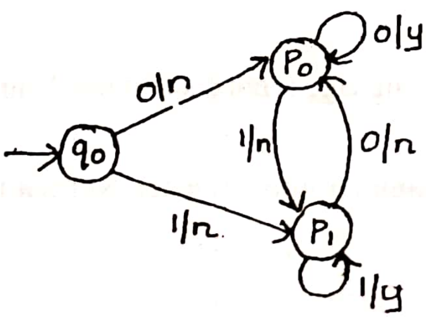


c) Define :

i) Non Deterministic Finite Automata.

ii) Proof and Give its classification. [4]

d) Convert the following Mealy machine to Moore machine [4]



P.T.O.

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Q2) a) State pumping lemma.

Using pumping lemma prove that $L=\{a^i b^i \mid i \geq 0\}$ is not regular.

b) Obtain a regular expression to accept the following strings over $\Sigma=\{a,b\}$

i) Starting with a and ending with b.

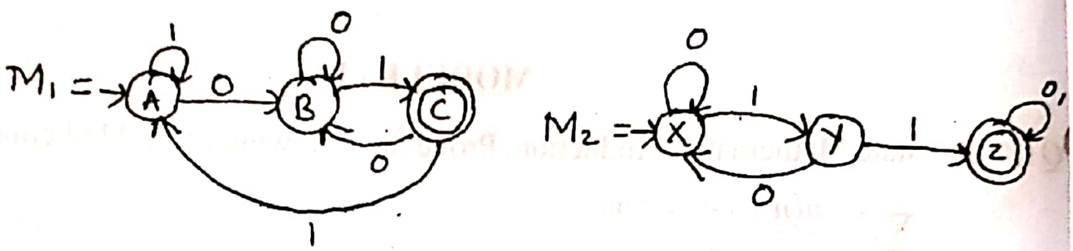
ii) Strings of a's and b's with alternate a's and b's.

c) Construct a $\in$ - NFA to accept the following regular expressions

i) (0 + 1)* (00 + 11) (0 +1)*

ii) (a + b) aba (a + b)*

d) Let



find

i) $L_1 - L_2$ where M_1 accepts L_1 & M_2 accepts L_2 respectively. [4]

MODULE - II

Q3) a) Construct a PDA to accept the following Language $L=\{a^n b^{2n} \mid n \geq 1\}$ Explain the behaviour of the above PDA with the help of a string. [8]

b) Define Chomsky Normal Form. [2]

c) Eliminate the useless symbols from the grammer

$S \rightarrow aA \mid bB$

$A \rightarrow aA \mid a$

$B \rightarrow bB$

$D \rightarrow ab \mid Ea$

$E \rightarrow ac \mid d$

[4]

d) Show that the following Language is not context free language $L=\{a^i b^i c^i \mid i \geq 1\}$. [6]

Q4) a) Convert the following grammer into Greibach Normal form

$S \rightarrow ABC \mid BaB$

$A \rightarrow aA \mid BaC \mid aaa$

$B \rightarrow bBb \mid a$

$C \rightarrow CA \mid AC$

[8]

b) Eliminate left Recursion and factor the following grammer [4]

$S \rightarrow S_1$

$S_1 \rightarrow S_1T \mid ab$

$T \rightarrow aTbb \mid ab$

c) Construct a bottom up PDA for the following [6]

$S \rightarrow S + T$

$S \rightarrow T$

$T \rightarrow T * a$

$T \rightarrow a$

d) Define Push Down Automata. [2]

MODULE - III

Q5) a) Give the variations of the Turing machine. [8]

b) Construct a Turing machine to accept the Language $L=\{w \mid w \in \{0+1\}^*\}$ containing the substring 001. [6]

c) What do you mean by computing a partial function with a turing machine. Explain with the help of an example. [6]

Q6) a) Explain how will you combine two turing machines. [6]

b) Obtain a turing machine that computes n mod 2, replaces input string by the output of the operation. [6]

c) Give the encoding function for a universal turing machine. [6]

d) Why a Turing machine is said to be a language acceptor. [2]

MODULE - IV

Q7) a) "For any unrestricted grammer G = (V, Σ, S, P) there is a Turing machine T = (Q, Σ, T, q0, δ) with L(T) = L(G)". Justify this statement. [8]

b) What do you mean by enumerating a language by a Turing machine. [4]

c) Construct an context sensitive grammer for the following language $L=\{a^n b^n a^{2n} \mid n \geq 1\}$. [6]

d) Define Non self accepting. [2]

Q8) a) Describe the language generated by the unrestricted grammer with the productions given below [8]

i) $S \to ABCS / ABC$

$AB \to BA, AC \to CA, BC \to CB$

$BA \to AB, CA \to AC, CB \to BC$

$A \to a, B \to b, C \to c.$

ii) $S \to LaR, L \to LD|\in, Da \to aaD, DR \to R, R \to \in.$

b) Define [6]

i) Context Sensitive Grammer.

ii) Rice Theorem.

iii) Unrestricted Grammer.

c) Explain the relationship among different class of languages in Chomsky hierarchy. [4]

d) Define Generalized sequential machine. [2]

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COMP 5 – 2 (RC)

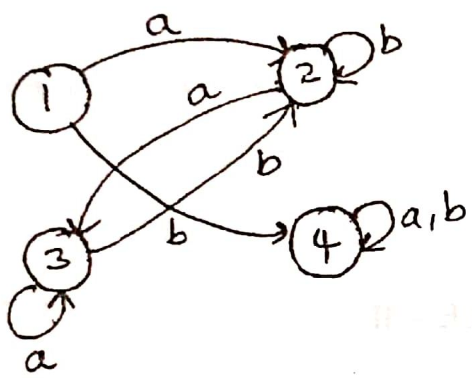
T.E. (Comp.) (Semester – V) (RC) Examination, November/December 2010
AUTOMATA LANGUAGE AND COMPUTATION

Duration: 3 Hours   Total Marks : 100

Instructions : *1) Attempt **any five** questions, choosing at least **one** from **each** Module.*
*2) Figures to the **right** indicate marks.*

MODULE – I

1. a) Check whether the string "abaaba" is accepted by the following DFA. 3



b) Define : 4

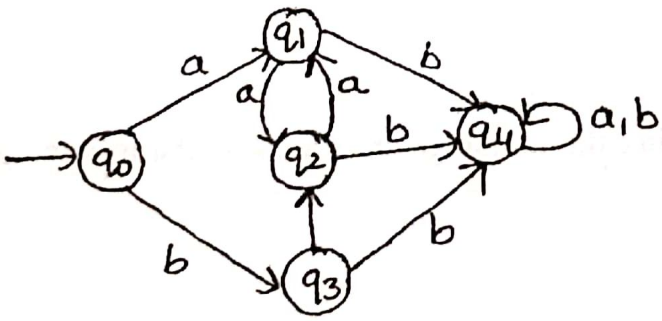
i) Moore machine

ii) Deterministic Finite Automata.

c) Show that $L = \{a^{n!} \mid n \geq 0\}$ is not regular. 6

d) What do you mean by distinguishable strings ? Let $L = \{x|x$ end's in $10\}$. Show that 00 and 01 are distinguishable with respect to L. 7

2. a) Minimize the following DFA, where qo, is the start state. 6



q_4 is the accepting state.

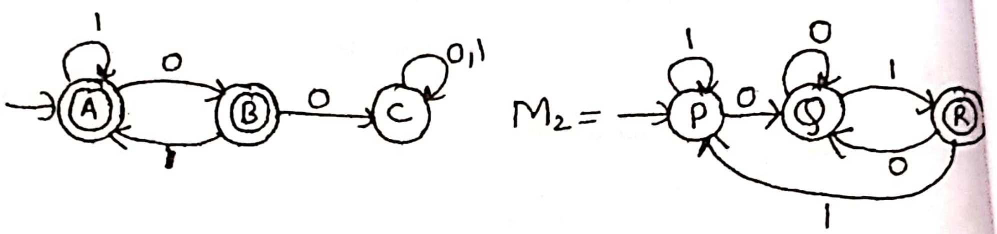
P.T.O.

b) Prove using mathematical induction.

$$\sum_{i=1}^{n} \frac{1}{i(i+1)} = \frac{n}{n+1} \quad \forall n \geq 0.$$

c) Explain substitutions and Homomorphism using examples.

d) M_1 =



find i) $L_1 \cup L_2$ ii) $L_1 - L_2$

If M_1 accepts L_1 and M_2 accepts L_2. 4

MODULE – II

3. a) Define Context Free Grammar. 2

b) Show that the following grammar is ambigous

$S \rightarrow iCtS \mid iCtSeS \mid a$

$C \rightarrow b$

$V = \{S, C\}\ \Sigma = \{i, t, e, a, b\}$. 5

c) Convert the following grammar to CNF. 8

$S \rightarrow AACD$

$A \rightarrow aAb \mid \epsilon$

$C \rightarrow aC \mid a$

$D \rightarrow aDa \mid bDb \mid \epsilon$

d) Construct a DPDA accepting the language generated by the following grammer. 5

$S \rightarrow SS \mid [S] \mid \{S\} \mid \epsilon$

a) Prove that if L_1 and L_2 are Context Free Languages then prove that $L_1 \cup L_2$ is also context free. 8

b) Write context free grammar equivalent to a regular expression. 4

$(0+1)^*(1+0)^*$

c) What is an ambigious grammar ? How will you prove that the grammar is ambigious show with the help of an example. 6

d) Define Push Down Automata. 2

MODULE – III

5. a) Define Turning machine. 2

b) Construct a Turing machine to accept the strings of the language $L = \{a, b\}^*\{aba\}$. 6

c) Give the encoding Function of Universal Turing machine. 8

d) What do you mean by characteristics function of a set ? Explain how a Turing machine relates to this function. 4

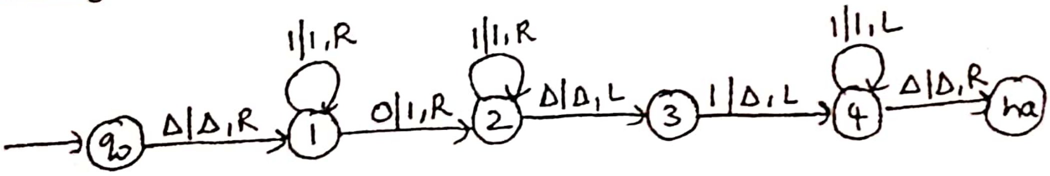
6. a) Construct a Turing Machine for accepting $L = \{a^n b^n \mid n \geq 1\}$. 6

b) Define : 4

i) Universal Turing machine

ii) Partial function computation.

c) Encode the following Turing machine using encoding function. Explain the working of a universal Turing machine. 10



P.T.O.

MODULE – IV

7. a) Obtain a generalized sequential machine that maps. 6

$L_1 = \{0^n 1^n \mid n \geq 1\}$ to $L_2 = \{a^{2n}b \mid n \geq 0\}$

b) Define : 10

i) Linear Bounded Automata.

ii) Abstract Families of Languages

iii) Decision Problem

iv) Context Sensitive Grammars.

c) State the Chomsky Hierarchy. 4

8. a) Obtain a context sensitive Grammar for the Language $L = \{a^i b^i c^i \mid n \geq 1\}$ 6

b) State :

1) Rice Theorem

2) Unrestricted Grammer.

3) Reducing one Language to another. 6

c) "If L_1 and L_2 are recursively enumerable Language over Σ then $L_1 \cup L_2$ is also recursively Language" prove the above statement. 6

d) Define Trio's and full Trio's. 2

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COMP 5 – 2 (RC)

T.E. (COMP) (RC) Semester – V Examination, May 2010
AUTOMATA LANGUAGE AND COMPUTATION

Duration: 3 Hours

Total Marks: 100

Instructions: *1) Answer **five** questions by selecting atleast **one from each** Module.*
*2) Make necessary assumptions **if required**.*

MODULE – I

1. a) Obtain a regular expression to each of the following languages over $\Sigma = \{a, b\}^*$ 6
   i) To accept the words with two or more letters but beginning and ending with the same letter.
   ii) To accept a language consisting of string's of a's and b's with alternate a's and b's.

b) Define : 4
   i) Deterministic finite automata
   ii) Moore machine.

c) Prove part 2 of Kleene's theorem given by the following statement.
"The language accepted by finite Automata is regular". 6

d) A deterministic finite automata with states 1-4 and input alphabet $\Sigma = \{a, b\}$ has following transition table. 4

q	$\delta(q, a)$	$\delta(q, b)$
1	{2}	{4}
2	{3}	{2}
3	{3}	{2}
4	{4}	{4}

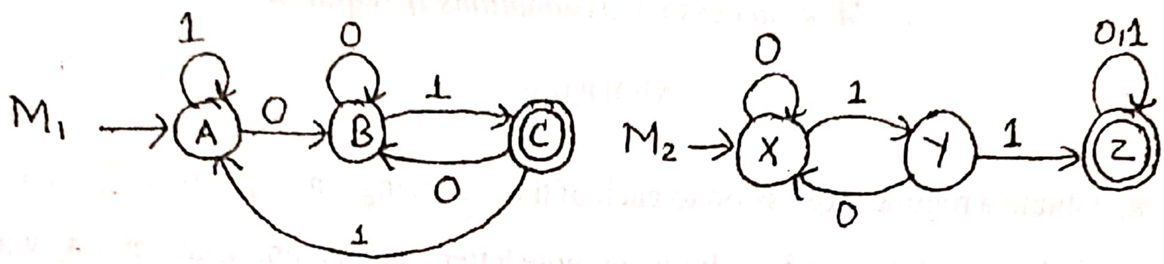
i) Draw transition diagram for above table.
ii) Calculate $\delta^*(1, abaaba)$.

P.T.O.

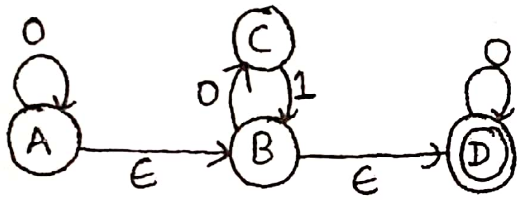
2. a) Let M_1 and M_2 given below be finite Automata's recognizing the languages L_1 and L_2 respectively. Draw finite Automata recognizing the following languages : 5

i) $L_1 \cup L_2$

ii) $L_1 - L_2$

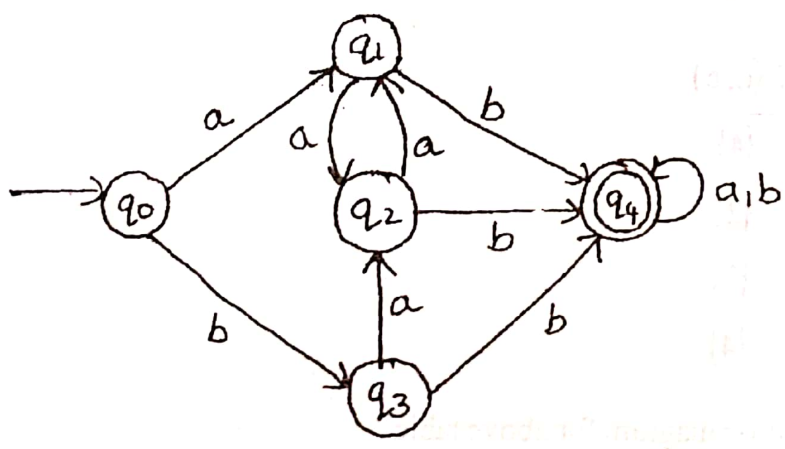


b) Convert the following $\in$-NFA to NFA. 5



c) Prove by pumping lemma. $L = \{a^i b^j / i > j\}$ is not regular. 5

d) Minimize the following deterministic finite automata. 5



MODULE – II

3. a) What is a context free grammar ? Show that the following language is not context free language $L = \{ww / w \in \{a, b\}^*\}$. 6

b) Eliminate useless symbols in the Grammar G = (V, T, P, S) where V = {S, A, B, C, D, E} T = {a, b, d} and P is given by the productions. 4

$P = \{ S \rightarrow aA|bB$

$A \rightarrow aA|a$ $\quad D \rightarrow ab|Ea$

$B \rightarrow bB$ $\quad E \rightarrow aC|d$

$\}$

c) Find an equivalent LL(1) grammar from the following : 4

$S \rightarrow S_1\$$

$S_1 \rightarrow aAb|aAA|aBb|bA$

$A \rightarrow aAb|ab$

$B \rightarrow bBa|ba$

d) Construct a bottom up PDA for the following : 6

$S \rightarrow S + T$

$S \rightarrow T$

$T \rightarrow T * a$

$T \rightarrow a$

4. a) State pumping lemma for a context free language. 3

b) Construct a Push Down Automata to accept the language. 6

$L = \{a^n b^{2n} | n \geq 1\}$

Explain the behaviour of PDA with the help of a string.

c) Define :

i) Chomsky normal form $\quad$ ii) Push Down Automata. 5

d) Prove that if L_1 and L_2 are context free languages then language $L_1 \cup L_2$ is also context free language. 6

MODULE – III

5. a) Define Turing machine. 2

b) Construct a Turing machine that creates a copy of its input string to the right of the input but with a blank separating the copy from the original. 8

c) State and explain church's hypothesis. 4

d) Give the encoding function for a "TM" universal Turing machine. 6

6. a) Explain how to construct a composite Turing machine. 4

b) Construct a Turing machine that computes the function $f(x) = m - n$ where $m \geq n$, m and n are both positive integer numbers. Assume that Turing machine uses unary notation. 6

c) Define : 6

i) Multitape Turing machine

ii) Non deterministics Turing machine.

d) Describe Universal Turing machine. 4

MODULE – IV

7. a) Define : 4

i) Unrestricted grammar

ii) Context sensitive grammar.

b) Simulate Turing machine for the following unrestricted grammar : 6

$S \rightarrow aBS|\in$

$aB \rightarrow Ba$

$Ba \rightarrow aB$

$B \rightarrow b$

c) Obtain a context sensitive grammar for : 5

$\{a^i b^i c^i / n \geq 1\}$

d) Explain the relationships among different class of languages in chomsky hierarchy. 5

8. a) "If L_1 and L_2 are recursively enumerable languages over Σ, then $L_1 \cup L_2$ is also recursively enumerable".
Prove the above theorem. 8

b) State Rice theorem. 2

c) Define : 4

i) Decision problem

ii) Reducing one language to another.

d) Obtain unrestricted grammar generating following language : 6

$L = \{a^i | i$ is a positive power of $2\}$.

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COMP 5 – 2 (RC)

T.E. (Comp.) Semester – V Examination, Nov./Dec. 2009
AUTOMATA LANGUAGES AND COMPUTATION

Duration : 3 Hours

Total Marks : 100

Instructions : 1) *Answer **five** questions by selecting atleast **one** from **each** Module.*
2) *Make **necessary** assumptions **if required**.*

MODULE – I

1. a) Prove by mathematical induction that every u, v $\in \Sigma^+$ $(uv)^R = v^R u^R$. **6**

b) Construct an $\in$-NFA equivalent to following regular expression.
$(a + b)^*$ ababb $(a + b)^*$. **4**

c) Prove the following statement :
Let L be the set accepted by non deterministic finite automata then there exists a deterministic finite automata that accepts L. **6**

d) Define the following : **4**
1) Non deterministic finite automata.
2) Extended transitions function δ^* for non deterministic finite automata.

2. a) State pumping lemma for regular sets show that $\left\{a^{n!} \mid n \geq 0\right\}$ is not regular. **6**

b) Minimize the DFA given by the following transition table : **8**

State	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.

where A is the start state and C is the accepting state for the deterministic finite automata.

c) Explain closure properties of regular sets. **4**

d) State MyHill Nerode theorem. **2**

P.T.O.

MODULE – II

3. a) Give context free grammars for the following : 4 5

i) $L = \{x \in \{0, 1\} / n_0(x) - n_1(x)\}$.

ii) $L = (011 + 1)^* (0 + 1)^*$.

b) Define Push Down automata. 2

c) Convert following context free grammar to Chomsky normal form : 8

$S \rightarrow AACD$

$A \rightarrow aAb | \in$

$C \rightarrow aC | a$

$D \rightarrow aDa | bDb | \in$.

d) Construct a Push Down Automata for the following grammar : 6

$S \rightarrow aABC$

$A \rightarrow aB | a$

$B \rightarrow bA | b$

$C \rightarrow a$.

4. a) What is an ambiguous grammar ? Is the following grammar ambiguous ? 5

$S \rightarrow aB | bA$

$A \rightarrow as | bAA | a$

$B \rightarrow bS | aBB | b$.

b) What do you mean by Greibach Normal Form ? 2

c) Write the rules for obtaining context free grammar corresponding to a given Push Down Automata.
Convert the following PDA to CFG using above rules. 8

1) $\delta(q_0, 0, z_0) = (q_0, xz_0)$

2) $\delta(q_0, 0, x) = (q_0, xx)$

3) $\delta(q_0, 1, x) = (q_1, \in)$

4) $\delta(q_1, 1, x) = (q_1, \in)$

5) $\delta(q_1, \in, x) = (q_1, \in)$

6) $\delta(q_1, \in, z_0) = (q_1, \in)$.

d) Construct a top Down Push Down Automata for the following $s \rightarrow (s)s | \in$. 5

MODULE – III

5. a) Construct a Turing machine for accepting $L = \{0^n 1^n | n \geq 1\}$. 6

b) Explain the variations of Turing machine in brief. 6

c) Define : 4

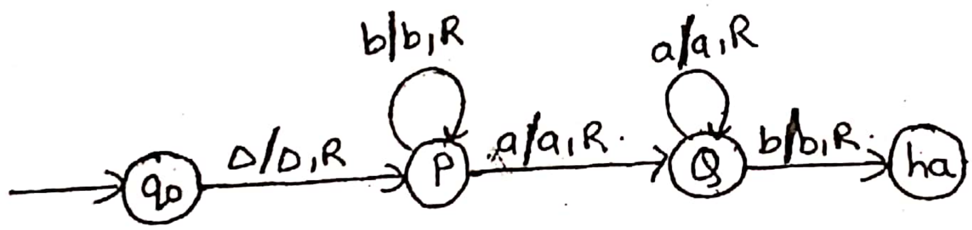
i) Acceptance by a Turing machine

ii) Characteristics function of a set.

d) Explain how a partial function is computed using Turing machine. 4

6. a) Construct a Turing machine to compute the function $f(x) = x + y$ where x and y are positive integers. Assume Turing machine to use unary notation. 6

b) Give the encoding function for an universal Turing machine. Encode the following Turing machine using above function. 8



c) Define : 4

i) Turing machine

ii) Church Turing thesis.

d) Why is a Turing machine said to be a language acceptor ? 2

MODULE – IV

7. a) Construct a phrase structure grammar for the set of all strings containing a's followed by same number of b's and followed by same number of c's. 6

b) Define : 6

i) Linear Bounded Automata.

ii) Context Sensitive Grammars.

iii) Abstract Families of Languages.

c) Enumerate and explain closure properties of context free languages. 6

d) Define decision problem. 2

8. a) Obtain a generalised sequential machine that maps $L_1 = \{0^n 1^n | n \geq 1\}$ to $L_2 = \{a^{2n} b | n \geq 0\}$. 6

b) State Rice theorem. 2

c) Obtain Turing machine for an unrestricted grammar given below. 6

$s \rightarrow aBs/\epsilon$

$aB \rightarrow Ba$

$Ba \rightarrow aB$

$B \rightarrow b$

d) If L_1 and L_2 are recursively enumerable language over Σ then $L_1 \cap L_2$ is also recursively enumerable.
Prove the above statement. 6