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17CS54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: *Answer FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Explain with example,
(i) Strings (ii) Language (iii) Function on string **(06 Marks)**

b. Discuss standard operations on Languages with example. **(04 Marks)**

c. Construct DFSM for the following languages :
(i) $L = \{\omega \in \{a, b\}^* \mid \omega \text{ contains no more than one } b\}$
(ii) $L = \{\omega \in \{a, b\}^* \mid \omega \text{ contains Even number of a's and odd number of b's}\}$
Give the transition Table and show that aabaa is accepted. **(10 Marks)**

OR

2 a. Convert the following $\in$ –NFSM to DFSM by eliminating $\in$ –transition.

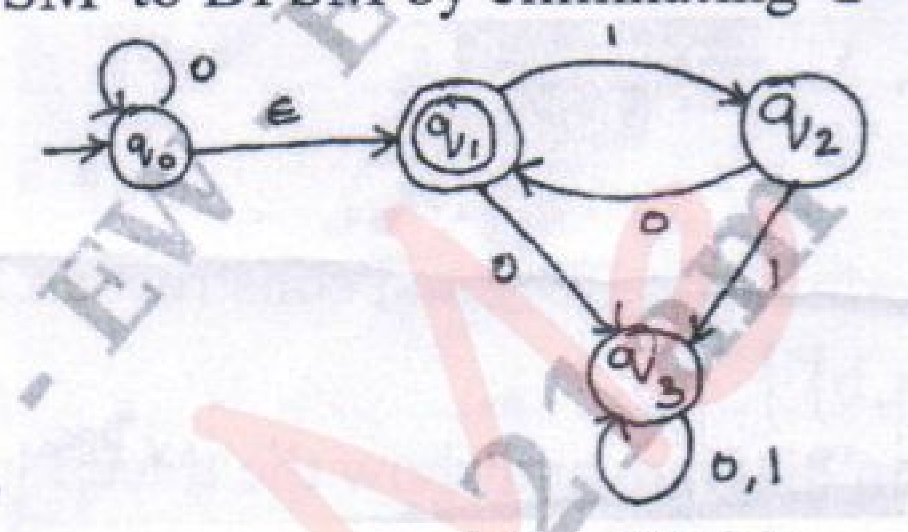

Fig. Q2 (a) **(10 Marks)**

b. Define distinguishable and indistinguishable states. Minimize the number of states in DFSM.

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

(10 Marks)

Module-2

3 a. Define Regular expression. Write RE for the following :
(i) Language of all strings of 0's and 1's that have odd number of 1's.
(ii) Language of all strings of 0's and 1's that has at least one pair of consecutive 0's.
(iii) The Language of all strings of 0's and 1's that have no pair's of consecutive 0's. **(10 Marks)**

b. Prove with an example that the class of language can be defined with regular Grammar is exactly the regular language. **(10 Marks)**

OR

4 a. Using Kleen's theorem, prove that any language that can be defined with a Regular expression can be accepted by some FSM. **(10 Marks)**

b. State and prove pumping lemma for regular language and show that the language $L = \{a^P \mid P \text{ is a prime number}\}$ is not regular. **(10 Marks)**

Module-3

5 a. Define context Free Grammar. Construct CFG for the following languages:

(i) Balanced parantheses.

(ii) $L = \{\omega \in \{a,b\}^* \mid \omega \text{ contains substring ab}\}$ and derive two strings for each language along with parse tree. **(10 Marks)**

b. Explain deterministic PDA and construct DPDA for language given and give the trace for the string abbaab and aababb.
$L = \{a^n b^m a^m b^n \mid m.n > 0 \text{ and } n \neq m\}$. **(10 Marks)**

OR

6 a. Discuss Chomsky normal form and Greibach normal form. Convert the following Grammar to Chomsky Normal form,

$S \rightarrow aACa$

$A \rightarrow B \mid a$

$B \rightarrow C$

$C \rightarrow cC \mid \in$

(10 Marks)

b. Explain Non deterministic PDA and construct an NPDA for the language.
$L = \{\omega\omega^R \mid \omega \in \{a,b\}^*\}$
Give the transition diagram and show the trace for a string abaaba. **(10 Marks)**

Module-4

7 a. State pumping Lemma for context free language. **(10 Marks)**

b. Define Turing Machine. Design TM to accept the language $L = \{a^n b^n c^n \mid n \geq 1\}$. Draw the transition diagram and show the moves made by TM for the string aabbcc. **(10 Marks)**

OR

8 a. Explain with a neat diagram the working of TM and design a TM to accept all set of palidrom over $\{0,1\}^*$. Also show the transition diagram and instantaneous description on string "10101". **(14 Marks)**

b. Discuss the relationship between the deterministic context free language and the languages that are not inherently ambigus. **(06 Marks)**

Module-5

9 a. With a neat diagram, explain variants of Turing Machines. **(10 Marks)**

b. Explain with example,
(i) Decidability (ii) Decidable languages (iii) Undecidable language. **(10 Marks)**

OR

10 a. Discuss Halting problem and post correspondence problem with respect to TM. **(10 Marks)**

b. Define non-deterministic TM and prove that there in a deterministic TM 'M' such that, $T(M) = T(M_1)$. **(10 Marks)**

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17CS54

Fifth Semester B.E. Degree Examination, July/August 2022
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following terms with example:
(i) Alphabet (ii) Power of an Alphabet (iii) Language **(06 Marks)**

b. Define Deterministic FSM. Draw a DFSM to accept decimal strings which are divisible by 3. **(07 Marks)**

c. Convert the following NDFSM to its equivalent DFSM [Refer Fig.Q1(c)].

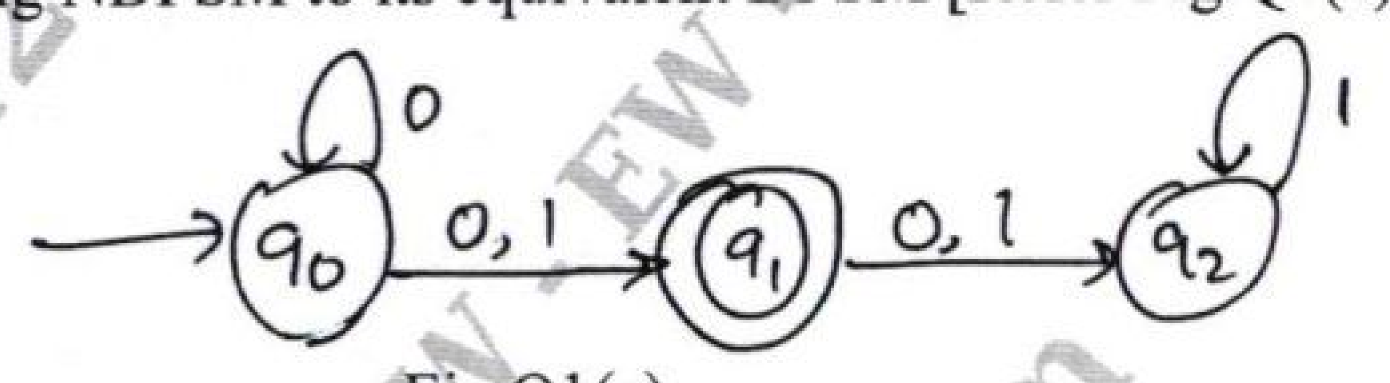

Fig.Q1(c)

Also write transition table for DFSM. **(07 Marks)**

OR

2 a. Minimize the following FSM [Refer Fig.Q2(a)].

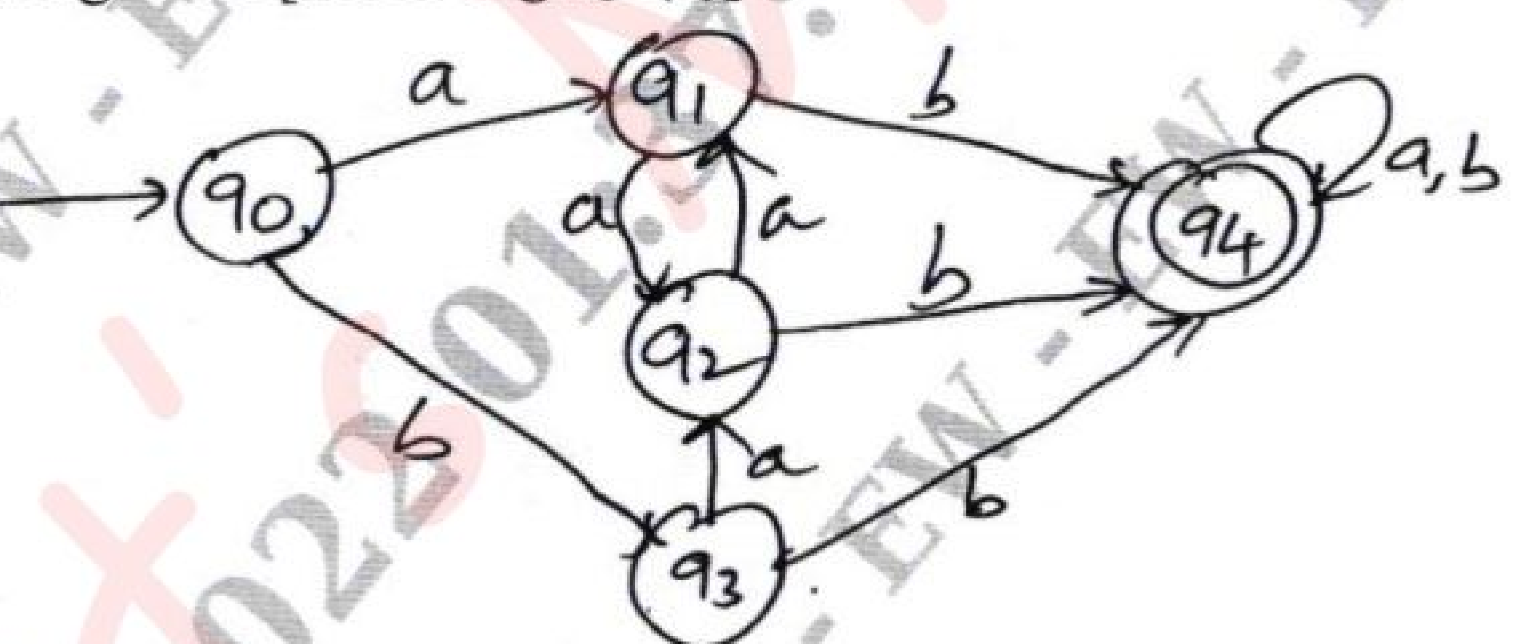

Fig.Q2(a) **(07 Marks)**

b. Construct a Melay Machine which accepts a binary number and produces its equivalent 1's complement. **(07 Marks)**

c. Construct a Moore machine which accepts strings of a's and b's and count the number of times the pattern 'ab' present in the string. **(06 Marks)**

Module-2

3 a. Define Regular Expression. Obtain Regular Expression for the following :
(i) $L = \{ a^n b^m \mid m + n \text{ is even} \}$
(ii) $L = \{ a^n b^m \mid m \geq 1, n \geq 1, nm \geq 3 \}$
(iii) $L = \{ w : |w| \bmod 3 = 0 \text{ where } w \in (a, b)^* \}$
(iv) $L = \{ a^{2n} b^{2m} \mid n \geq 0, m \geq 0 \}$ **(08 Marks)**

b. Let L be the language accepted by the following finite state machine. [Refer Fig.Q3(b)]

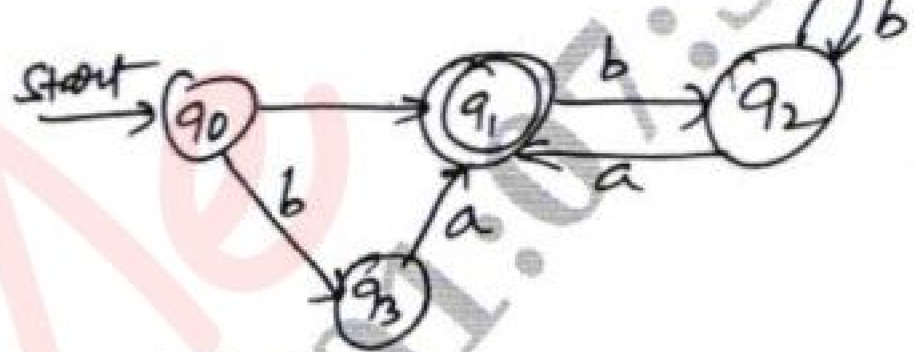

Fig.Q3(b)

Indicate for each of the following regular expression, whether it correctly describes L:

(i) $(a \cup ba)\, bb^{*}a$

(ii) $(\in \cup b)\, a\, (bb^{*}a)^{*}$

(iii) $ba \cup ab^{*}a$

(iv) $ba \cup ab^{*}a \cup a$

(v) $(a \cup ba)\, (bb^{*}a)^{*}$ **(05 Marks)**

c. Consider the DFSM shown in below Fig.Q3(c).

Fig.Q3(c)

Obtain the regular expressions $R_{ij}^{(0)}$, $R_{ij}^{(1)}$ and simplify the regular expression as much as possible. **(07 Marks)**

OR

4 a. State and prove the pumping Lemma theorem for regular language. **(07 Marks)**

b. Show that the language $L = \{a^n b^n \mid n \ge 0\}$ is not regular. **(07 Marks)**

c. If L_1 and L_2 are regular language then prove that $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^{*} are regular languages. **(06 Marks)**

Module-3

5 a. Define CFG. Write CFG for the language

(i) $L = \{0^n 1^n \mid n \ge 1\}$

(ii) $L = \{a^n b^{n+3} \mid n \ge 1\}$ **(08 Marks)**

b. Consider the grammar

$E \to +EE \mid *EE \mid -EE \mid x \mid y$

Find LMD and RMD for the string +*– xy xy and write parse tree. **(08 Marks)**

c. Is the following grammar Ambiguous?

$S \to iC + S \mid iC + SeS \mid a$

$C \to b$ **(04 Marks)**

OR

6 a. Define PDA. Obtain PDA to accept the language $L(M) = \{w \subset w^R \mid w \in (a+b)^{*}\}$, where w^R is reverse of w by a final state. **(08 Marks)**

b. Convert the following CFG into PDA

$S \to aABC$

$A \to aB \mid a$

$B \to bA \mid b$

$C \to a$ **(06 Marks)**

c. Convert the following grammar into CNF:

$S \rightarrow 0A \mid 1B$
$A \rightarrow 0AA \mid 1S \mid 1$
$B \rightarrow 1BB \mid 0S \mid 0$ (06 Marks)

Module-4

7 a. Show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free. (06 Marks)
b. Prove that CFL's are closed under union, concatenation and star operation. (06 Marks)
c. Design a Turing Machine to accept $L = \{0^n 1^n \mid n \geq 1\}$ (08 Marks)

OR

8 a. Design a Turing machine to accept $L = \{a^n b^n c^n \mid n \geq 1\}$. Show the moves made by TM for the string aabbcc. (10 Marks)
b. Explain with neat diagram, the working of a Turing machine model. (05 Marks)
c. Write a note on Multitape turing machine. (05 Marks)

Module-5

9 a. Design a turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Draw the transition diagram. Show the moves made by this machine for the string 000111. (12 Marks)
b. Write short notes on :
(i) Post correspondence problem
(ii) Linear bounded automata. (08 Marks)

OR

10 Write short notes on:
a. Church turing thesis
b. Quantum computers
c. Classes of P and NP
d. Undecidable languages (20 Marks)

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17CS54

Fifth Semester B.E. Degree Examination, Aug./Sept. 2020
Automata Theory & Computability

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define DFA. What are the differences between DFA and NFA? **(06 Marks)**

b. Construct the DFA for the following languages over $\sum = \{a, b\}$:

(i) Set of all strings ending with a and b.
(ii) Set of all strings not containing the substring "aab".
(iii) Set of all strings with exactly three consecutive a's. **(09 Marks)**

c. Construct the NDFA model for the following language:

$L = \{\omega \in \{a, b\}^* : \omega = aba \text{ or } |\omega| \text{ is even}\}$

$L = \{\omega : \text{there is a symbol } a_i \in \sum \text{ not appearing in } \omega\}$ where $\sum = \{a, b, c, d\}$ **(05 Marks)**

OR

2 a. Convert the following $\in$-NFA to DFA. (Ref. Fig. Q2 (a)). **(08 Marks)**

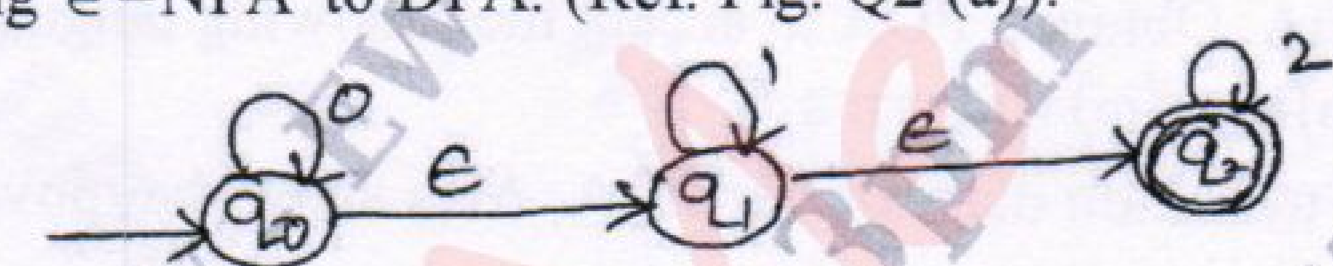

Fig. Q2 (a)

b. Minimize the following automata: (Ref. Fig. Q2 (b)) **(08 Marks)**

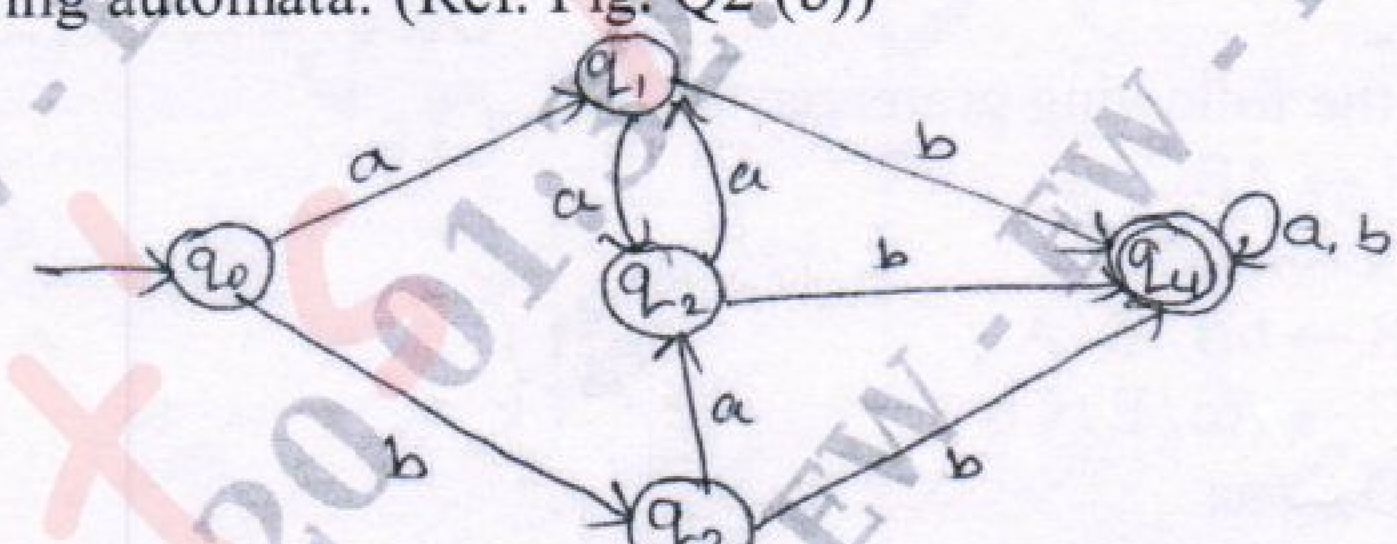

Fig. Q2 (b)

c. Different between Mealy machine and Moore machine with example. **(04 Marks)**

Module-2

3 a. Define Regular expression. Convert the following automation to a regular expression. **(08 Marks)**

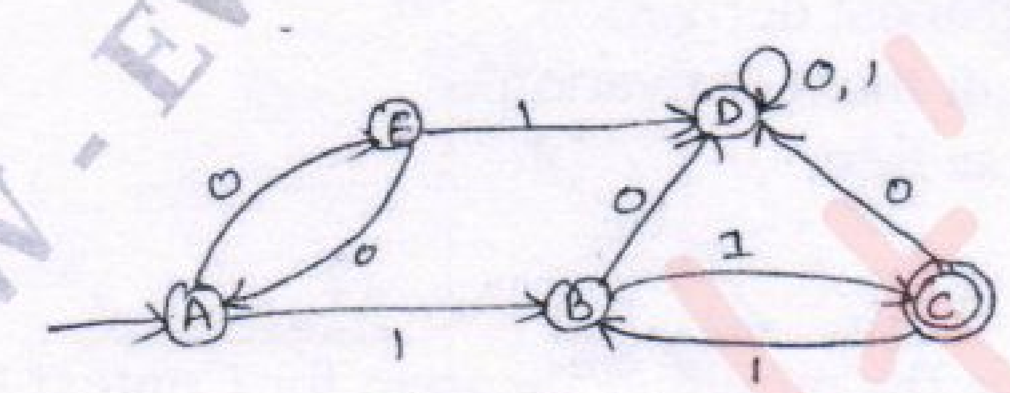

Fig. Q3 (a)

b. Construct the NFA for the following regular expression $\frac{(0+1)^*}{(0+1)}$ **(04 Marks)**

c. State and prove the pumping lemma for regular languages. **(08 Marks)**

OR

4 a. Show that $L = \{O^n \mid n \text{ is prime}\}$ is not regular? **(06 Marks)**

b. State and prove that regular languages are closed under complement, intersection difference, reverse and letter substitution. **(08 Marks)**

c. Write the regular expression for the following languages:

$L = \{a^n b^m \mid m + n \text{ is even}\}$

$L = \{a^n b^m \mid m > 1, n \geq 1\ nm \geq 3\}$ **(06 Marks)**

Module-3

5 a. Define Regular Grammar? Write CFG for the following languages:

$L = \{0^n 1^n \mid n \geq 1\}$

L = { strings of a's and b's with equal no. of a's and b's} **(05 Marks)**

b. Define ambiguous grammar and show that following expression grammar is ambiguous over the string $id + id * id$. Write equivalent unambiguous grammar for the same?

Grammar

$E \rightarrow E + E$

$E \rightarrow E - E$

$E \rightarrow E * E$

$E \rightarrow E / E$

$E \rightarrow id$ **(05 Marks)**

c. Define PDA. Obtain a PDA to accept the following language:

$L = \{n_a(\omega) = n_b(\omega) \text{ where } n \geq 1\}$

Draw the transition diagram for PDA. Also show the moves made by the PDA for the string "aabbab". **(10 Marks)**

OR

6 a. Obtain the following grammar in CNF

$S \rightarrow ABC$

$A \rightarrow aC / D$

$B \rightarrow bB / E / A$

$C \rightarrow Ac / E / Cc$

$D \rightarrow aa$ **(10 Marks)**

b. Define inherently ambiguous language with example. **(04 Marks)**

c. Let G be the grammar.

$S \rightarrow aB / bA$

$A \rightarrow a / aS / bAA$

$B \rightarrow b / bS / aBB$

For the string aaabbabbba find

(i) Left most derivation.

(ii) Right most derivation.

(iii) Parse tree. **(06 Marks)**

Module-4

7 a. State and prove the pumping theorem for Context Free Languages.

Show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not content free. **(12 Marks)**

b. Define Turing machine and explain with neat diagram, the working of a basic turing machine. **(08 Marks)**

OR

8 a. Design a TM to accept $\{0^n1^n2^n \mid n \geq 1\}$ and show the moves made by the machine for the string 000111222? **(10 Marks)**
b. Describe in detail decidable languages. **(05 Marks)**
c. Briefly explain the technique for Turing machine construction? **(05 Marks)**

Module-5

9 a. Explain the following:
(i) Non deterministic Turing Machine.
(ii) Multitape Turing Machine. **(10 Marks)**
b. Discuss the following:
(i) Recersively enumerable language.
(ii) Post correspondence problem. **(10 Marks)**

OR

10 Write short note on the following:
a. Quantum computer.
b. Class NP.
c. Church Turing Thesis.
d. Model of linear bounded automation.
e. Halting problem of Turing Machine. **(20 Marks)**

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CBCS SCHEME

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Fifth Semester B.E. Degree Examination, June/July 2023
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following with example:
(i) String (ii) Language (iii) Alphabet (iv) Symbol **(04 Marks)**

b. Define Deterministic Finite State Machine (DFSM). Draw DFSM to accept the following language:
i) $L = \{w \in \{a,b\}^* : W$ has all strings that ends with substrings abb$\}$
ii) $L = \{w \in \{a,b\}^* : W$ contains even number of a's and off number of b's$\}$ **(07 Marks)**

c. Convert the following non-DFSM to its equivalent DFSM.

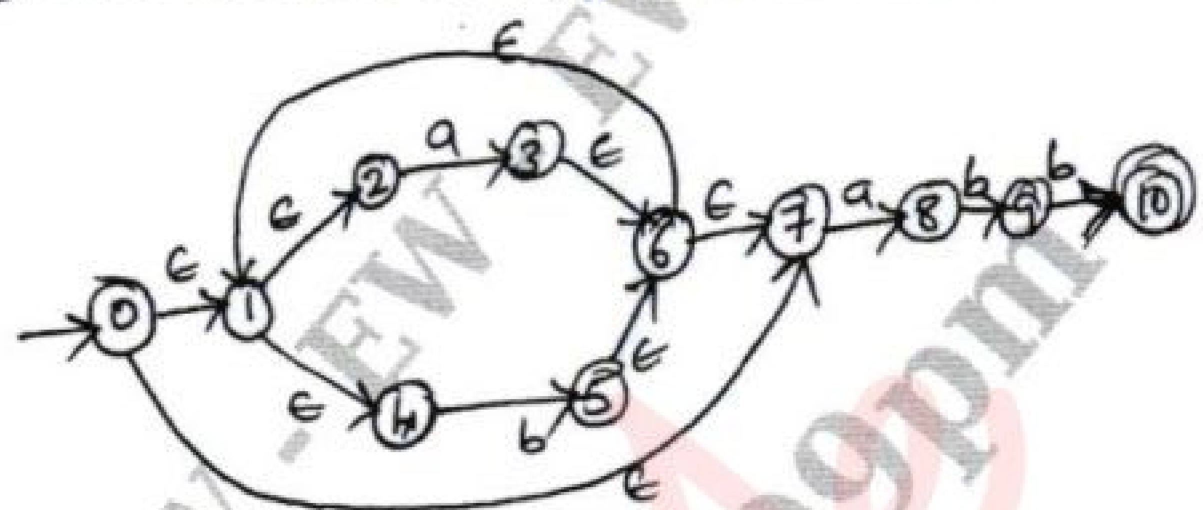

Fig.Q1(c) **(09 Marks)**

OR

2 a. Define distinguishable and indistinguishable states. Minimize the following DFSM.

	δ	a	b
→	A	B	F
	B	G	C
*	C	A	C
	D	C	G
	E	H	F
	F	C	G
	G	G	E
	H	G	C

(i) Draw the table of distinguishable and indistinguishable state for the automata.
(ii) Construct the minimum state equivalent of automata.
(10 Marks)

b. Write difference between DFSM and NDFSM and ∈-NDFSM with example. **(05 Marks)**

c. Convert the following NDFSM to DFSM using subset construction method.

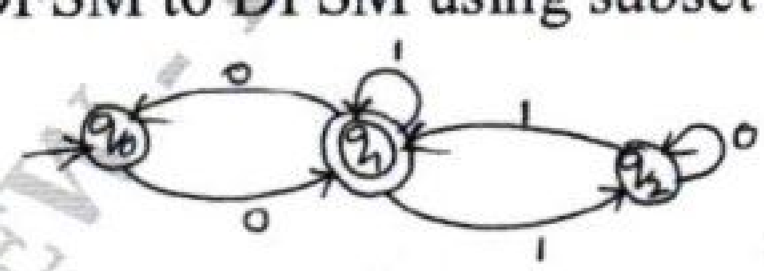

Fig.Q2(c) **(05 Marks)**

Module-2

3 a. Define Regular Expression. Write RE for the following languages:
i) Strings of a's and b's whose length is 2
ii) Set of strings consisting of even number of a's followed by odd number of b's **(05 Marks)**

b. Construct an $\in$-NFA for the regular expression
$ab(a + b)^*$ **(05 Marks)**

c. Obtain a RE for the finite automata shown in Fig.Q3(c).

Fig.Q3(c) **(10 Marks)**

OR

4 a. State and prove that regular languages are closed under complement, intersection, difference. **(06 Marks)**

b. State and prove pumping lemma for regular languages. **(08 Marks)**

c. Prove that the following language is not regular.
$L = \{0^n 1^n / |n \geq 0\}$ **(06 Marks)**

Module-3

5 a. Define Context Free Grammar (CFG). Write a CFG to specify
(i) Set of all palindromes over $\Sigma = \{a, b\}$ (ii) $L = \{a^n b^{2n} : n \geq 0\}$
(iii) $L = \{a^n b^{n+1} : n \geq 0\}$ **(07 Marks)**

b. Convert the grammar into Chomsky Normal Form (CNF)
$S \to aAD$, $A \to aB \mid bAB$, $B \to b$, $D \to d$ **(05 Marks)**

c. Obtain left most derivation, rightmost derivation for the string aabbbb and also write a derivation tree. **(08 Marks)**

OR

6 a. Obtain a PDA to accept the language
$L(M) = \{ww^R | w \in \{a,b\}^*\}$
Draw the graphical representation of the PDA. Show the moves made by this PDA for the string aabbaa. **(10 Marks)**

b. Obtain the corresponding PDA for the grammar
$S \to aABC$, $A \to aB \mid a$, $B \to bA \mid b$, $C \to a$ **(10 Marks)**

Module-4

7 a. State and prove the pumping lemma theorem for context tree languages. Show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free. **(12 Marks)**

b. If L_1 and L_2 are context free languages, then prove that $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are context free languages. **(08 Marks)**

OR

8 a. Explain with neat diagram, the working of a Turing Machine. **(08 Marks)**

b. Design a Turing machine to accept the language $L = \{0^n 1^n : n \geq 1\}$
Draw the transition diagram and show the moves made by this turing machine for the string 0011. **(12 Marks)**

Module-5

9 a. Briefly explain the techniques for turing machine construction. **(10 Marks)**

b. Explain the following :
(i) Non-deterministic turing machine (ii) Multitape turing machine **(10 Marks)**

OR

10 Write short notes on the following :
a. Halting problem of turing machine b. The post correspondence problem
c. Quantum Computers d. Class NP **(20 Marks)**

CBCS SCHEME

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17CS54

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define strings language and automata with examples. **(05 Marks)**

b. Define DFSM. Design DFSM to accept each of the following languages:

i) $L = \{w \in \{0, 1\}^* : w$ corresponds to the binary encoding, without leading 0's, of natural numbers that are evenly divisible by 4$\}$.

ii) $L = \{w \in \{a, b\}^* : (\#_a(w) + 2 - \#_b(w)) \equiv_5 0\}$. ($\#_a(w)$ is the number of a's in w). **(12 Marks)**

c. Differentiate Moore machines and Mealy machines. **(03 Marks)**

OR

2 a. Define NDFSM. Convert the following NDFSM to its equivalent DFSM. Refer Fig.Q.2(a). **(12 Marks)**

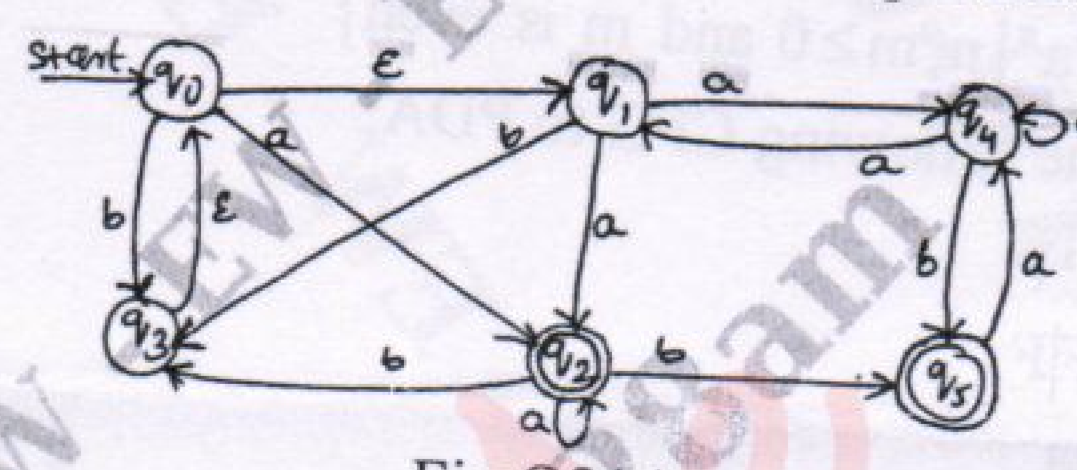

Fig.Q2(a)

b. Let M be the following DFSM. Use min DFSM to minimize M. Refer Fig.Q.2(b). **(08 Marks)**

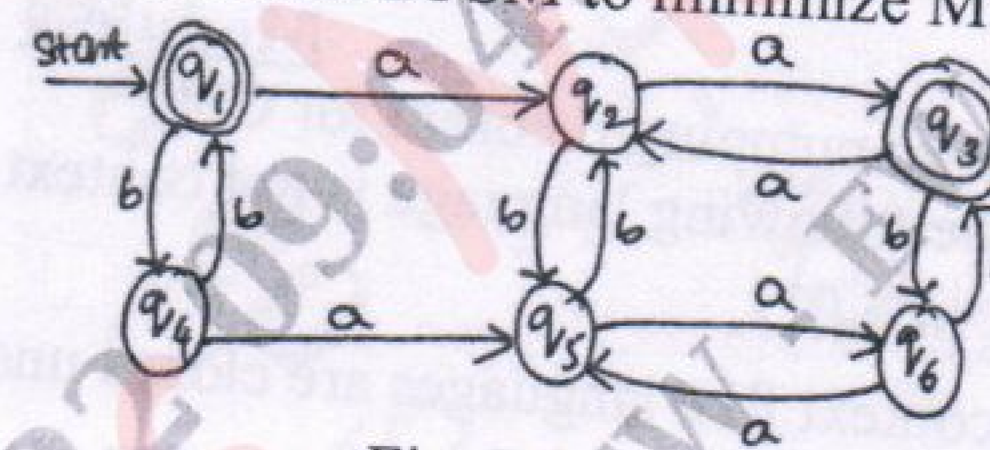

Fig.Q.2(b)

Module-2

3 a. Define regular expression and write regular expressions for the following languages:

i) $L = \{w \in \{a, b\}^* : |w|$ is even$\}$

ii) $L = \{w \in \{0, 1\}^* : w$ corresponds to the binary encoding, without leading 0's, of natural numbers that are powers of 4$\}$

iii) $L = \{a^n b^m c^p \mid n \le 4, m \ge 2, p \le 2\}$ **(10 Marks)**

b. Build a regular expression equivalent to DFSM given below. Refer Fig.Q.3(b). **(05 Marks)**

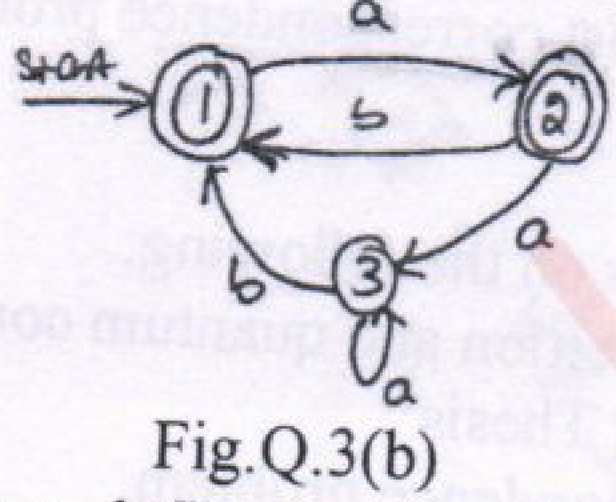

Fig.Q.3(b)

c. Build a FSM that accepts the language defined by regular expression : $(b \cup ab)^*$ **(05 Marks)**

OR

4 a. Define regular grammar, and show a regular grammar for the language:
$L = \{w \in \{a,b\}^* : |w| \text{ is even}\}$ (06 Marks)

b. State and prove the pumping theorem for regular languages. (08 Marks)

c. Show that the language $L = \{a^n b^n | n \geq 0\}$ is not regular. (06 Marks)

Module-3

5 a. Define Context Free Grammar. Design a CFG for each of the following languages:

i) $L = \{a^n b^{n+2} | n \geq 0\}$

ii) $L = \{a^i b^j c^k | j = i + k, \forall i, j, k \geq 0\}$

iii) $L = \{a^n b^m \mid m \geq n, m - n \text{ is even}\}$ (10 Marks)

b. Convert the following grammar to Chomsky normal form:

$S \rightarrow aACa$

$A \rightarrow B|a$

$B \rightarrow C|c$

$C \rightarrow cC|\varepsilon$ (10 Marks)

OR

6 a. Define PDA. Obtain a PDA to accept the language
$L = \{a^n b^m a^n | n, m \geq 0 \text{ and } m \text{ is even}\}$ (10 Marks)

b. Convert the following CFG to PDA:

$E \rightarrow E + T|T$

$T \rightarrow T * F|F$

$F \rightarrow (E)|id$ (06 Marks)

c. When a PDA is called as deterministic PDA? (04 Marks)

Module-4

7 a. State and prove pumping theorem for CFL. (08 Marks)

b. Show that the following language is not context free
$L = \{a^n b^n c^n | n \geq 0\}$ (06 Marks)

c. Prove that context free languages are closed under Union and concatenation. (06 Marks)

OR

8 a. With a neat block diagram, explain the working of basic model for Turing machine. (06 Marks)

b. Design a Turing machine that accepts $L = \{0^n 1^n | n \geq 0\}$. Draw the transition diagram and show the moves for the string 0011. (10 Marks)

c. Briefly discuss the techniques for Turing machine construction. (04 Marks)

Module-5

9 a. With a neat diagram, explain the model of linear bounded automation. (08 Marks)

b. Explain working of multitape turning machine. (06 Marks)

c. Explain how a post correspondence problem can be treated as a game of dominoes. (06 Marks)

OR

10 Write short notes on the following:

a. Quantum computation and quantum computers (10 Marks)

b. Church – Turing Thesis (05 Marks)

c. The post-correspondence problem. (05 Marks)

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CBCS SCHEME

USN | | | | | | | | | | | **17CS54**

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define Language, Grammer and Automata with examples. **(04 Marks)**

b. Define DFSM. Draw a DFSM to accept the Language.

i) $L = \{awa : w \in (a, b)^*\}$. Verify for the string aabaa.

ii) Set of an string having a substring abb over $\sum = \{a, b\}$. Verify for the string aabba. **(08 Marks)**

c. Convert the following NDFSM to its equivalent DFSM (Refer Fig Q1(c))

Fig Q1(c) **(08 Marks)**

OR

2 a. Constant an NDFSM for multiple keywords

$L = \{w \in (a, b)^* : \exists x, y \in \{a, b\}^*$ where

$((w = x\ abbaay) \vee (w = xbabay))\}$ **(04 Marks)**

b. Minimize the following Finite State Machine using partition method. (Refer Fig Q2(b))

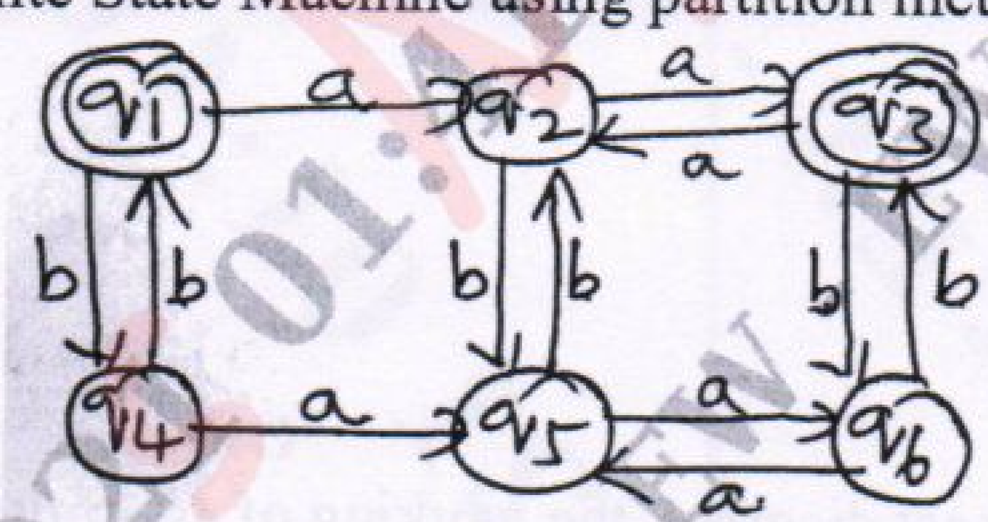

Fig Q2(b) **(08 Marks)**

c. Differentiate between DFSM, NDFSM and $\in$-NDFSM with examples. **(08 Marks)**

Module-2

3 a. Define Regular expression? Obtain the Regular expression for the following languages.

i) $L = \{a^{2n}\ b^{2n+1}\ ; n \geq 0, m \geq 0\}$

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

iii) Set of string of 0's and 1's whose 10^{th} symbol from the right end side is 1. Justify the answers. **(08 Marks)**

b. State and prove pumping Lemma for regular languages. **(08 Marks)**

c. Define Regular Grammer. Obtain Regular grammer for the language $L = \{w \in (a, b)^*\ ;$ w ends with the pattern aaaa$\}$. **(04 Marks)**

OR

4 a. Prove that for every regular defined by regular expression is also defined by Finite State Machine. **(08 Marks)**

b. Prove that the following Language is not regular

$L = \{ww^R; w \in (0+1)^*$ is not regular$\}$ **(08 Marks)**

c. Construct an NFSM which accepts the regular expression $(a+b)^*abb$. **(04 Marks)**

Module-3

5 a. Define Context Free Grammer. Obtain the Context Free Grammer for the following :
i) $L = \{ww^R : w \in (a, b)^*\}$
ii) Write a CFG to generate balanced parenthesis
Where Bal = {w ∈ {), (}* ; parenthesis are balanced}.
Justify the answers. **(08 Marks)**

b. Define Leftmost and rightmost derivations with examples. **(04 Marks)**

c. What is ambiguous grammer? Show that the following grammer is ambiguous for the string id + id * id. $E \rightarrow E + E \mid E - E \mid E * E \mid E / E \mid id$ **(08 Marks)**

OR

6 a. Define PDA, and Instantaneous description of PDA. Obtain a PDA to accept the language. $L = \{wcw^R : w \in (a, b)^*\}$. Draw the transition diagram of PDA, show the moves by this PDA for the string abbcbba. **(10 Marks)**

b. What is CNF and GNF? Convert the grammer in CNF
$S \rightarrow ABa$
$A \rightarrow aab$
$B \rightarrow Ac$ **(05 Marks)**

c. For the following CFG
$S \rightarrow asbb/aab$
Obtain the corresponding PDA. **(05 Marks)**

Module-4

7 a. State the prove Pumping Lemma theorem for Context Free Languages. **(08 Marks)**

b. Show that $L = \{a^n n^n c^n \mid n \geq 0\}$ is not context free. **(08 Marks)**

c. Remove all unit production from the grammer
$S \rightarrow AB$
$A \rightarrow a$
$B \rightarrow C|b$
$C \rightarrow D$
$D \rightarrow E|bc$
$E \rightarrow d|Ab$ **(04 Marks)**

OR

8 a. Explain with neat diagram, the working of a Turing Machine Model. **(06 Marks)**

b. Design a Turing Machine to accept the language $L = \{0^n 1^n 2^n \mid n \geq 1\}$. Draw the transition diagram. Show that moves made by this machine for the string 001122. **(10 Marks)**

c. Briefly explain the techniques for Turing Machine construction. **(04 Marks)**

Module-5

9 a. Design a Turing Machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Draw the transition diagram show the moves made by this machine for the string 000111. **(10 Marks)**

b. Explain the following :
i) Multitape Turing machine
ii) Post correspondence problem. **(10 Marks)**

OR

10 Write short notes on :
a. Non Deterministic Turing Machine
b. Halting Problem of Turing Machine
c. Quantum Computation with example
d. Model of linear bounded automation. **(20 Marks)**

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Fifth Semester B.E. Degree Examination, July/August 2021
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Define the following terms with examples:
(i) Alphabet (ii) Strings (iii) Kleene's closure
(iv) Languages (v) Concatenation **(05 Marks)**

b. Draw a DFA to accept the following languages.
(i) L = {w ∈ {a – z}*, all five vowels a, e, i, o and u occur in w in alphabetical order}
(ii) L = {w ∈ {a, b}*, set of all strings containing the substring "aab"} **(06 Marks)**

c. Convert the following ∈-NFA to its equivalent DFA. [Refer Fig.Q1(c)]

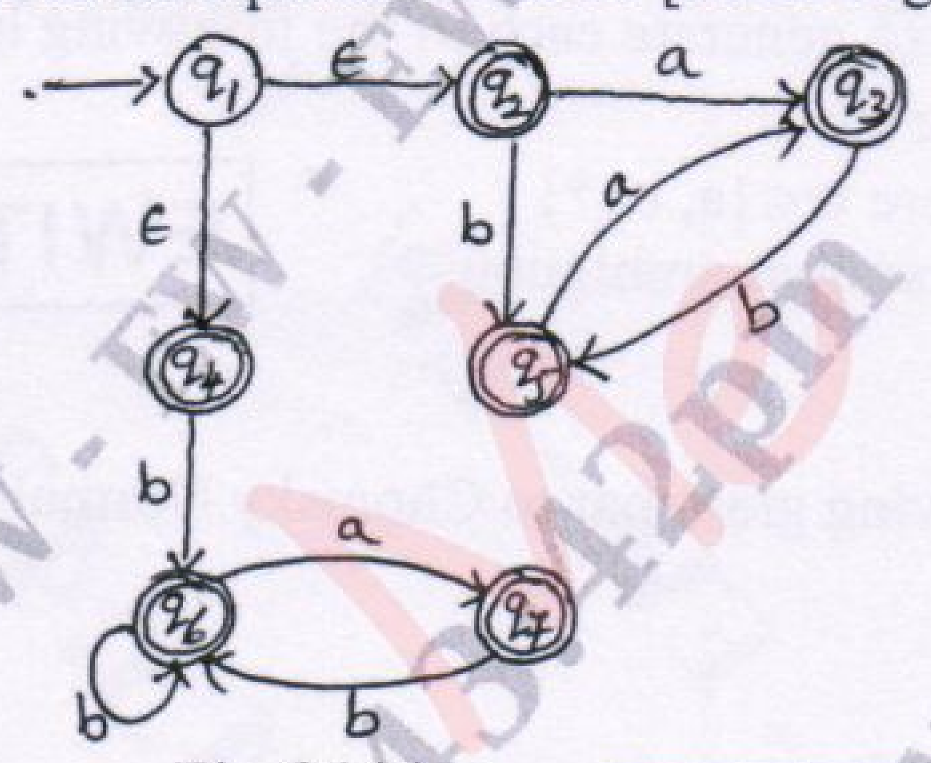

Fig.Q1(c) **(09 Marks)**

2 a. Obtain a DFA to accept the following language.
L = {w ∈ {a, b}*, $N_a(w)$ mod 5 = 0 and $N_b(w)$ mod 3 = 0} **(06 Marks)**

b. Give the differences between DFA, NFA and ∈-NFA. **(05 Marks)**

c. Minimize the following DFSM. [Refer Fig.Q2(c)]

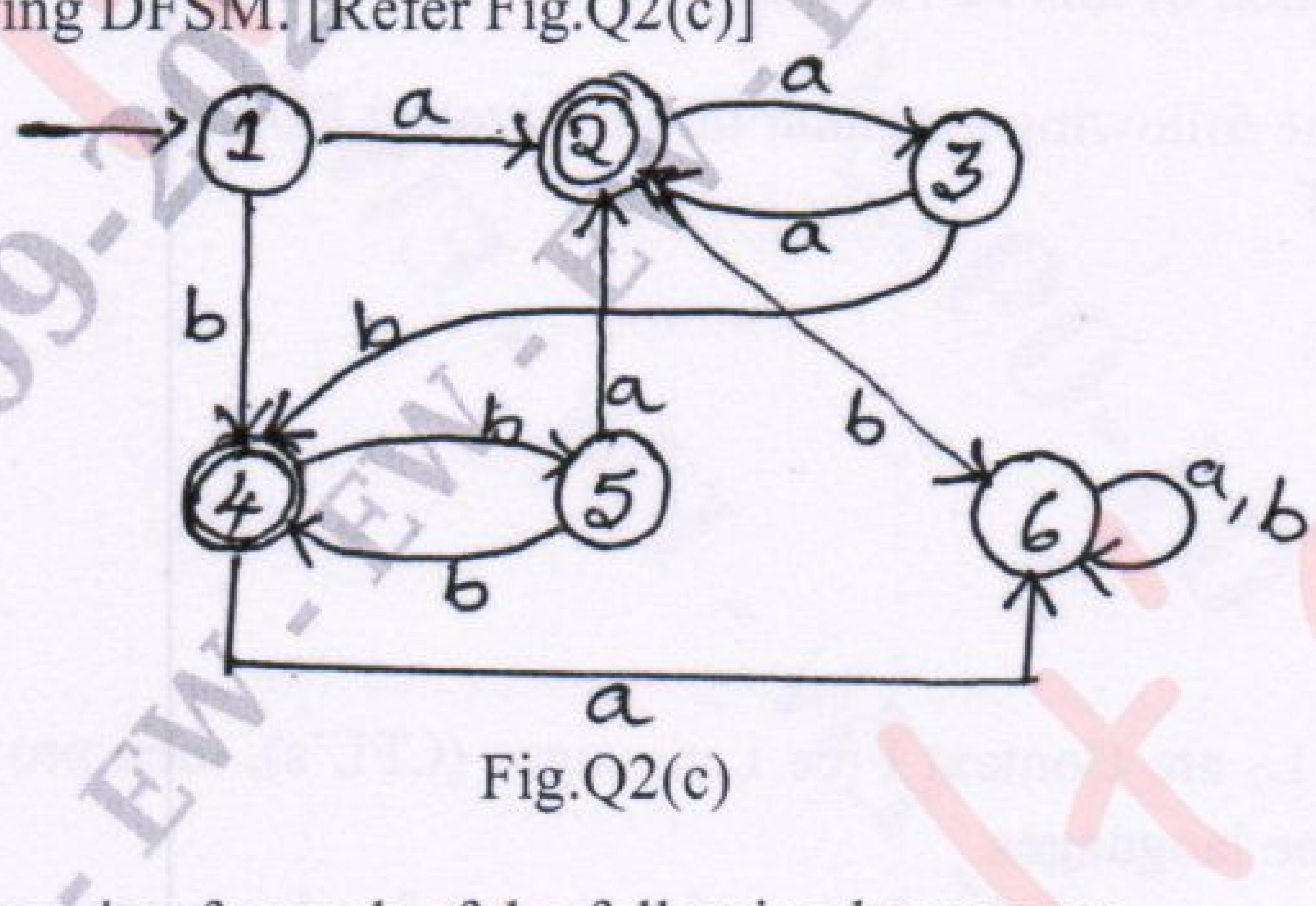

Fig.Q2(c) **(09 Marks)**

3 a. Obtain a regular expression for each of the following languages:
(i) L = {w|w∈{a, b}* with atleast three consecutive zero's} **(03 Marks)**
(ii) L = {w∈{a, b}* set of all strings starting with a and ending with b} **(03 Marks)**
(iii) L = {w|w∈{a, b}* whose second symbol from the right end is 'a'} **(04 Marks)**

b. Obtain the regular expression for the following FSM using Kleene's theorem.

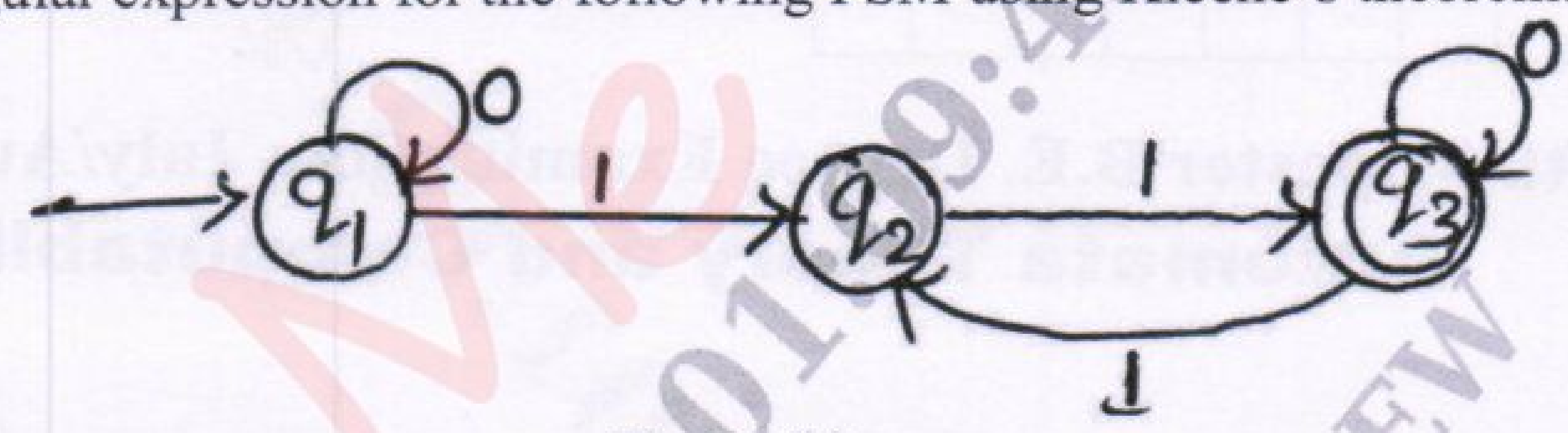

Fig.Q3(b) **(10 Marks)**

4 a. Show that the following languages are not regular:
(i) $L = \{a^n b^n \mid n \geq 0\}$ (ii) $L = \{1^p \mid p \text{ is prime}\}$ **(08 Marks)**

b. Simplify the following regular expression $((a^* \cup \phi)^* \cup aa)\ (b \cup bb)^*\ b^*\ ((a \cup b)^* b^* \cup ab)^*$ **(06 Marks)**

c. If L_1 and L_2 are regular languages, then prove that $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are regular languages. **(06 Marks)**

5 a. Obtain a grammar to generate each of the following languages:
(i) $L = \{a^n b^{2n} : n \geq 0\}$
(ii) $L = \{ww^R \text{ where } w \in \{a, b\}^*\}$ **(05 Marks)**

b. If the following grammar ambiguous?
$S \rightarrow aS \mid X$
$X \rightarrow aX \mid a$ **(05 Marks)**

c. Convert the following grammar to Chomsky Normal Form (CNF).
$S \rightarrow aACa$
$A \rightarrow B \mid a$
$B \rightarrow C \mid c$
$C \rightarrow cC \mid \in$ **(10 Marks)**

6 a. Define PDA and obtain a PDA to accept a string of balanced parenthesis. **(04 Marks)**

b. Construct a PDA to accept the language $L = \{wcw^R \mid w \in \{a, b\}^*\}$. Draw the graphical representation of this PDA. Show the moves made by this PDA for the string "abCba" **(10 Marks)**

c. Convert the following grammar into equivalent PDA.
$E \rightarrow E + T$
$E \rightarrow T$
$T \rightarrow T * F$
$T \rightarrow F$
$F \rightarrow (E)$
$F \rightarrow id$ **(06 Marks)**

7 a. If L_1 and L_2 are Context Free Languages (CFL's), then prove $L_1 \cup L_2$, $L_1 \cdot L_2$ and L_1^* are context free languages. **(05 Marks)**

b. State and prove pumping lemma for context free languages and show that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free. **(10 Marks)**

c. Explain with neat diagram the working of turing machine model. **(05 Marks)**

8 a. Explain with neat diagram, the model of Linear Bounded Automata (LBA). **(06 Marks)**

b. Design a TM (Turing Machine) that accepts $L = \{0^n 1^n \mid n \geq 1\}$. **(06 Marks)**

c. Consider the turing description given in the following table. Draw the computation sequence of the input string "00". **(08 Marks)**

Present State	Tape symbols		
	b	0	1
$\rightarrow q_1$	$1 L q_2$	$0 R q_1$	
q_2	$b R q_3$	$0 L q_2$	$1 L q_2$
q_3	-	$b R q_4$	$b R q_5$
q_4	$0 R q_5$	$0 R q_4$	$1 R q_4$
q_5	$0 L q_2$		

9 a. M is a turing machine represented by the transition diagram. Obtain the computation sequence of M for processing the input string "0011". {Refer Fig.Q9(a)]

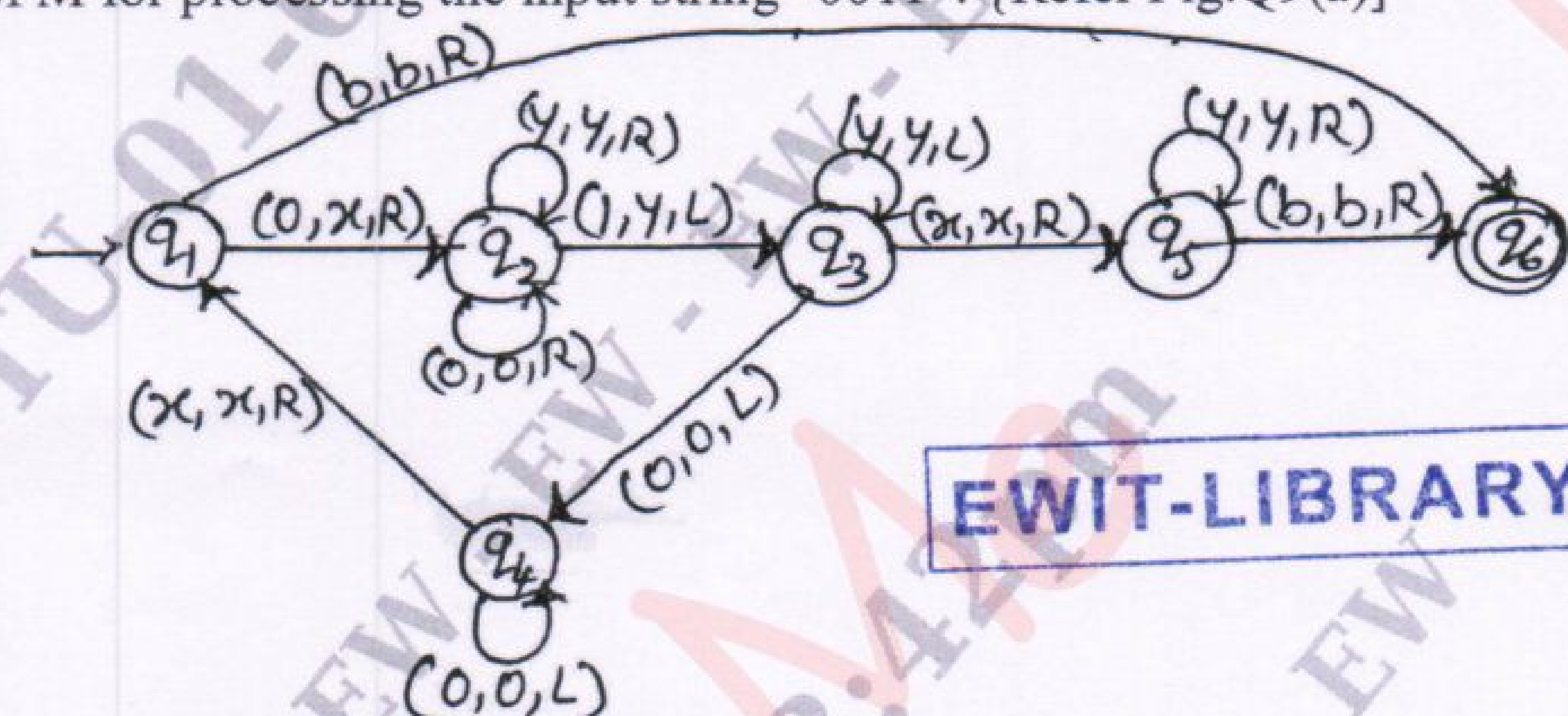

Fig.Q9(a) **(06 Marks)**

b. Design a Turing Machine (TM) to recognize all strings consisting of an even number of 1's. **(04 Marks)**

c. Design a Turing Machine (TM) to recognize the language. $L = \{1^n 2^n 3^n \mid n \geq 1\}$ **(10 Marks)**

10 Write short notes on:

a. Decidable and undecidable languages **(05 Marks)**

b. Halting problem of TM **(05 Marks)**

c. Post-correspondence problem **(05 Marks)**

d. Church-Turing thesis **(05 Marks)**

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