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15CS54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 80

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

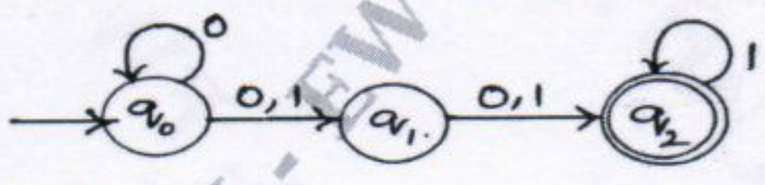
Module-1

1 a. Define the following with example :
i) String ii) Language iii) Alphabet iv) DFSM. **(08 Marks)**

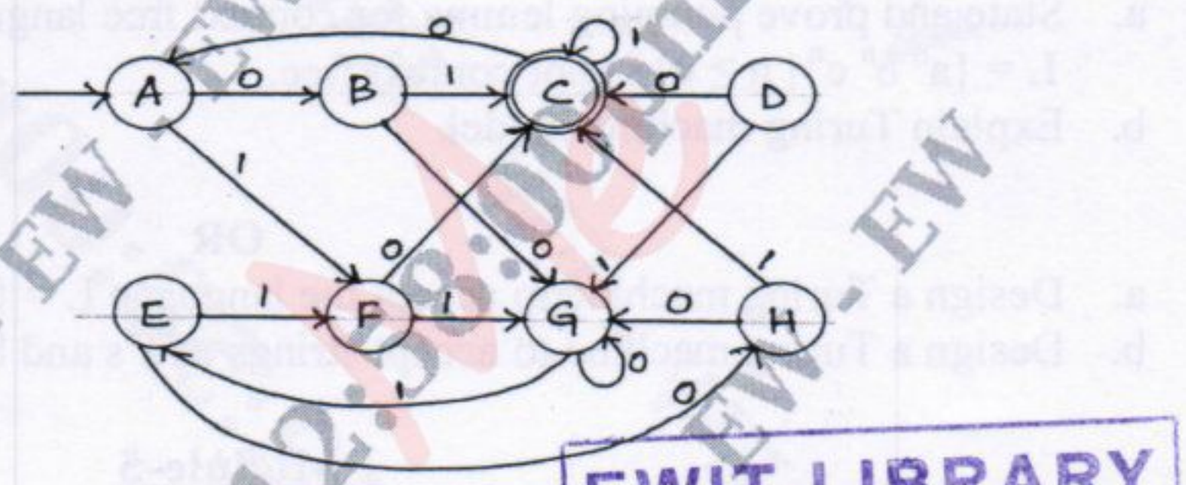
b. Design a DFSM to accept each of the following languages :
i) $L = \{W \in \{0, 1\}^* : W \text{ has } 001 \text{ as a substring}\}$
ii) $L = \{W \in \{a, b\}^* : W \text{ has even number of a's and even number of b's}\}$. **(08 Marks)**

OR

2 a. Define NDFSM. Convert the following NDFSM to its equivalent DFSM. **(08 Marks)**



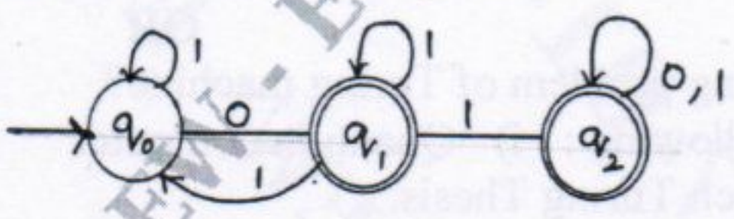
b. Minimize the following DFSM. **(08 Marks)**



Module-2

3 a. Define Regular expression and write Regular expression for the following language.
i) $L = \{a^{2n} b^{2m} \mid n \geq 0 , m \geq 0\}$ **(08 Marks)**
ii) $L = \{a^n b^m \mid m \geq 1 , n \geq 1 , nm \geq 3\}$.

b. Obtain the Regular expression for the following FSM. **(08 Marks)**



OR

4 a. Define a Regular grammar. Design regular grammars for the following languages.
i) Strings of a's and b's with at at least one a.
ii) Strings of a's and b's having strings without ending with ab.
iii) Strings of 0's and 1's with three consecutive 0's. **(08 Marks)**

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

Module-3

5 a. Define context free grammar. Design a context free grammar for the languages. **(08 Marks)**

i) $L = \{0^m 1^m 2^n \mid m \geq 0 \ , \ n \geq 0\}$ ii) $L = \{a^i b^j \mid i \neq j \ , \ i \geq 0 \ , j \geq 0\}$

iii) $L = \{a^n b^{n-3} \mid n \geq 3\}$.

b. Consider the grammar G with production.

$S \rightarrow AbB$

$A \rightarrow aA \mid \in$

$B \rightarrow aB \mid bB \mid \in$ **(08 Marks)**

Obtain leftmost derivation , rightmost derivation and parse tree for the string aaabab.

OR

6 a. Define a PDA. Obtain a PDA to accept

$L = \{a^n b^n \mid W \in \{a, b\}^*\}$. Draw the transition diagram. **(08 Marks)**

b. Convert the following grammar into equivalent PDA.

$S \rightarrow aABC$

$A \rightarrow aB \mid a$ **(08 Marks)**

$B \rightarrow bA \mid b$

$C \rightarrow a$.

Module-4

7 a. State and prove pumping lemma for context free languages. Show that **(10 Marks)**

$L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free.

b. Explain Turing machine model. **(06 Marks)**

OR

8 a. Design a Turing machine to accept the language $L = \{0^n 1^n 2^n \mid n \geq 1\}$. **(08 Marks)**

b. Design a Turing machine to accept strings of a's and b's ending with ab or ba. **(08 Marks)**

Module-5

9 a. Explain the following :

i) Non deterministic Turing machine ii) Multi – tape Turing machine. **(06 Marks)**

b. Define the following :

i) Recursively enumerable language ii) Decidable language. **(06 Marks)**

c. What is Post correspondence problem? **(04 Marks)**

OR

10 a. What is Halting problem of Turing machine? **(06 Marks)**

b. Define the following : i) Quantum computer ii) Class NP. **(06 Marks)**

c. Explain Church Turing Thesis. **(04 Marks)**

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15CS54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Briefly describe the applications of Theory of computation. **(04 Marks)**

b. Define DFSM. Build DFSM for the following languages. **(08 Marks)**

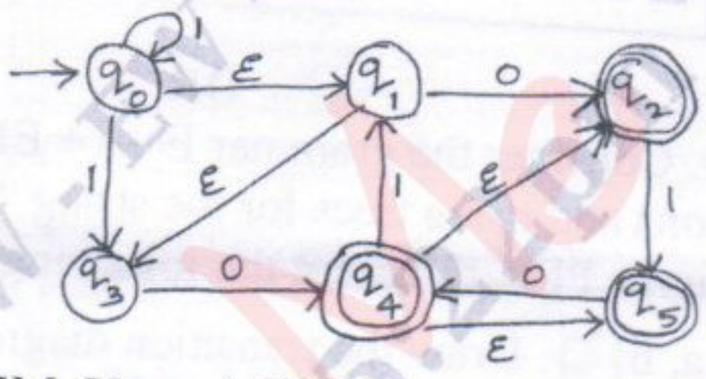
i) $L = \{w \in \{a, b\}^* : \text{every a in w is immediately followed by b}\}$

ii) $L = \{w \in \{a, b\}^* : w \text{ does not contain substring aab}\}$.

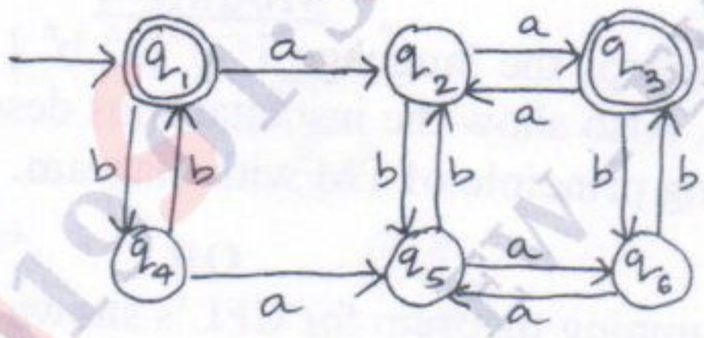
c. Describe Machine based hierarchy of language classes. **(04 Marks)**

OR

2 a. For the following NDFSM, use ndfsmtodfsm to construct an equivalent DFSM. Begin by showing the value of eps (q) for each state q : **(08 Marks)**



b. Let M be the following DFSM. Use minDFSM to minimize M. **(08 Marks)**



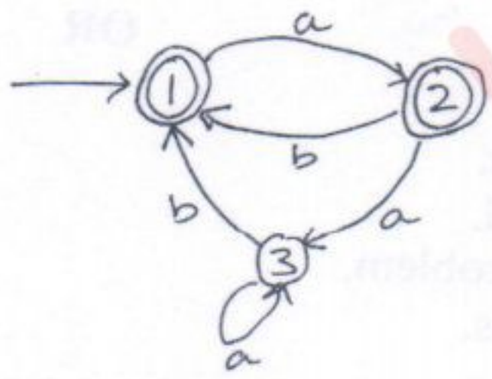
Module-2

3 a. Define Regular Expression. Write regular expression for the following :

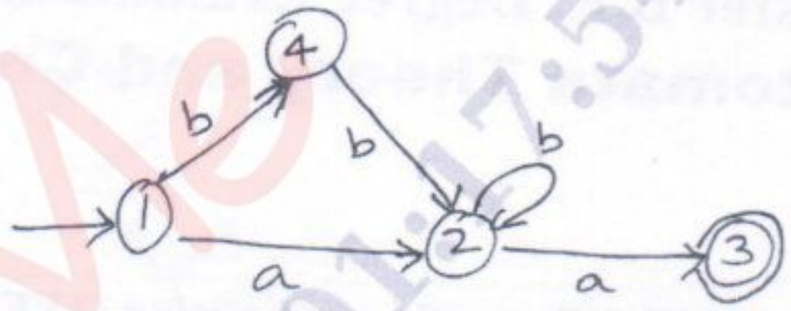
i) $L = \{w \in \{a, b\}^* : w \text{ does not end in ba}\}$

ii) $L = \{w \in \{0 - 9\}^* : w \text{ corresponds to the decimal encoding, without leading 0's , of an odd natural number}\}$. **(06 Marks)**

b. Consider the FSM M. Use the fsmtoregexheuristic algorithm to construct a regular expression that describes L(M). **(05 Marks)**



c. Consider the FSM M. Use fsmtoregex algorithm to construct a regular expression that describes L(M). **(05 Marks)**



OR

4 a. Show that regular languages are closed under complement and set difference. **(06 Marks)**

b. State and prove pumping lemma theorem for regular languages. And show that the language $L = \{a^n b^n : n \geq 0\}$ is not regular. **(10 Marks)**

Module-3

5 a. Define CFG. Design CFG for the languages.

i) $L = \{a^i b^j | \ 2i = 3j + 1\}$ ii) $L = \{0^{n+2} 1^n | \ n \geq 1\}$. **(08 Marks)**

b. Define Chomskey Normal form. Convert the following CFG to CNF.

$S \rightarrow a\ ACa$

$A \rightarrow a \mid B$

$B \rightarrow C \mid c$

$C \rightarrow cC \mid E$. **(08 Marks)**

OR

6 a. Define Ambiguity. Consider the grammar $E \rightarrow + EE \mid * EE \mid - EE \mid x \mid y$. Find the leftmost, rightmost derivations and parse trees for the string "+ * - xyxy". **(07 Marks)**

b. Define PDA. Design a PDA to accept the following language.

$L = \{ww^R : w \in \{a, b\}^*\}$. Draw the transition diagram for the constructed PDA. **(09 Marks)**

Module-4

7 a. Design a TM to accept the language $L = \{a^n b^n \mid n \geq 1\}$. Obtain the transition table and transition diagram. Also show the instantaneous description for the string "aabb". **(11 Marks)**

b. Explain the working principle of TM with diagram. **(05 Marks)**

OR

8 a. State and prove pumping theorem for CFL's shown that the language $L = \{a^n b^n c^n : n \geq 0\}$ is not context free. **(10 Marks)**

b. Explain the hierarchy within the class of CFL's (hierarchy of languages). **(03 Marks)**

c. Show that CFL's are closed under reverse. **(03 Marks)**

Module-5

9 a. Explain Multitape TM, with diagram. **(05 Marks)**

b. Prove that every language accepted by a multitape TM is acceptable by some standard TM. **(06 Marks)**

c. Explain the model of Linear Bounded Automata. **(05 Marks)**

OR

10 Write short notes on :

a. Undecidable languages.

b. Halting problem of TM.

c. Post correspondence problem.

d. Church – Turing Thesis. **(16 Marks)**

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15CS/IS54

Fifth Semester B.E. Degree Examination, June/July 2018
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. With a neat diagram, explain a hierarchy of language classes in automata theory. **(04 Marks)**

b. Define deterministic FSM. Draw a DFSM to accept decimal strings which are divisible by 3. **(06 Marks)**

c. Convert the following NDFSM to its equivalent DFSM. (Refer Fig.Q.1(c)).

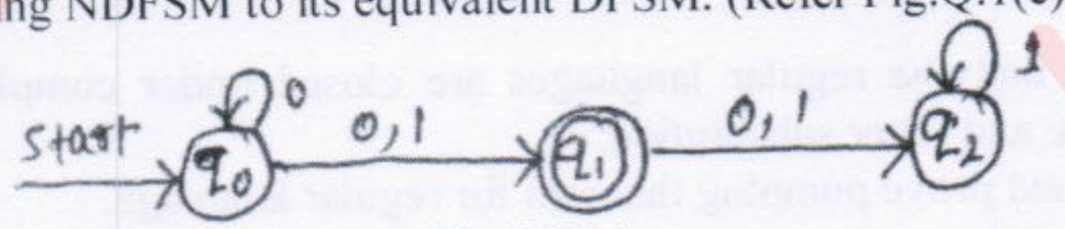

Fig.Q.1(c)

Also write transition table for DFSM. **(06 Marks)**

OR

2 a. Minimize the following finite automata, (Refer Fig.Q.2(a)). **(06 Marks)**

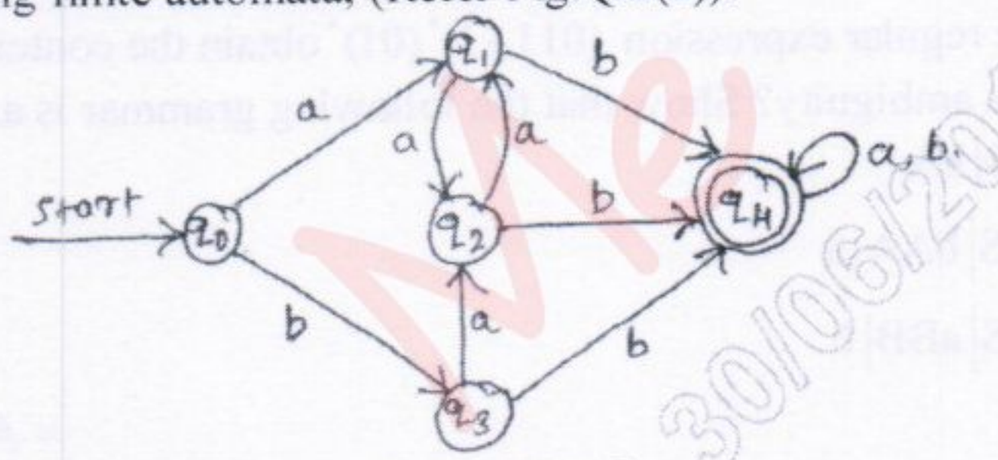

Fig.Q.2(a)

b. Construct a mealy machine for the following:

i) Design a mealy machine for a binary input sequence. Such that, if it has a substring 101, the machine outputs A. If input has substring 110, the machine outputs B. Otherwise it outputs C.

ii) Design a mealy machine that takes binary number as input and produces 2's complement of that number as output. Assume the string is read from LSB to MSB and end carry is discarded. **(06 Marks)**

c. Convert the following mealy machine to Moore machine. (Refer Fig.Q.2(c)). **(04 Marks)**

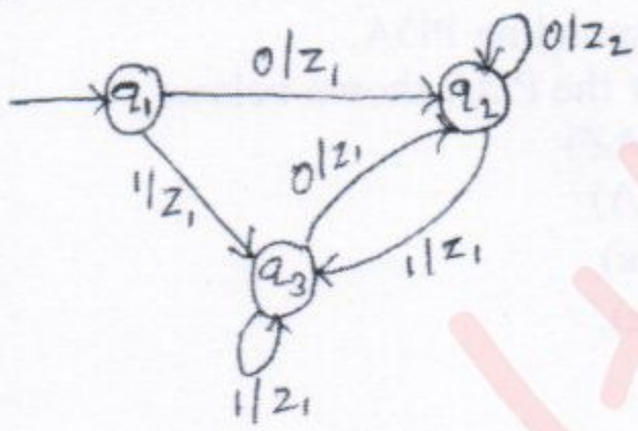

Fig.Q.2(c)

Module-2

3 a. Define regular expression. Obtain a regular expression for the following languages:

i) $L = \{a^n b^m | m+n \text{ is even}\}$.

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

iii) $L = \{w : |w| \bmod 3 = 0 \text{ where } w \in (a,b)^*\}$. **(08 Marks)**

b. Design an NDFSM that accept the language $L(aa^*(a+b))$. **(04 Marks)**

c. Convert the regular expression $(0+1)^* 1(0+1)$ to NDFSM. **(04 Marks)**

OR

4 a. If the regular grammars define exactly the regular language, then prove that the class of languages that can be defined with regular grammars is exactly the regular languages. **(04 Marks)**

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

c. State and prove pumping theorem for regular language. **(04 Marks)**

Module-3

5 a. Define a context-free grammar. Obtain the grammar to generate the language $L = \{w | n_a(w) = n_b(w)\}$. **(04 Marks)**

b. For the regular expression $(011+1)^*(01)^*$ obtain the context free grammar. **(04 Marks)**

c. What is ambiguity? Show that the following grammar is ambiguous.

$S \rightarrow aB | bA$

$A \rightarrow aS | bAA | a$

$B \rightarrow bS | aBB | b$. **(08 Marks)**

OR

6 a. Define PDA (Push Down automata). Obtain a PDA to accept the language $L(M) = \{wCw^R | wt(a+b)^*\}$, where WR is reverse of W by a final state. **(08 Marks)**

b. For the grammar:

$S \rightarrow aABB | aAA$

$A \rightarrow aBB | a$

$B \rightarrow bBB | A$

$C \rightarrow a$

Obtain the corresponding PDA. **(04 Marks)**

c. Obtain a CFG for the PDA shown below:

$f(q_0, a, Z) = (q_0, AZ)$

$f(q_0, a, A) = (q_0, A)$

$f(q_0, b, A) = (q_1, \varepsilon)$

$f(q_1, \varepsilon, Z) = (q_2, \varepsilon)$. **(04 Marks)**

Module-4

7 a. Consider the grammar

$S \rightarrow 0A \mid 1B$

$A \rightarrow 0AA \mid 1S \mid 1$

$B \rightarrow 1BB \mid 0S \mid 0$

Obtain the grammar in CNF. **(08 Marks)**

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

OR

8 a. With a neat diagram, explain the working of a basic Turing machine. **(04 Marks)**

b. Obtain a Turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. **(08 Marks)**

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

Module-5

9 a. Obtain a Turing machine to recognize the language $L = \{0^n 1^n 2^n \mid n \geq 1\}$. **(08 Marks)**

b. Prove that $HALT_{TM} = \{(M, W) \mid$ the Turing machine M halts on input W$\}$ is undecidable. **(04 Marks)**

c. With example, explain the quantum computation. **(04 Marks)**

OR

10 Write a short note on:

a. Multiple Turing machine

b. Non deterministic Turing machine

c. The model of linear bounded automaton

d. The post correspondence problem. **(16 Marks)**

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15CS/IS54

Fifth Semester B.E. Degree Examination, June/July 2019
Automata Theory and Computability

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following : i) string ii) alphabet iii) language. **(06 Marks)**

b. Design a deterministic finite state machine for the following language over $\sum = \{a, b\}$.

i) $L = \{W \mid\mid W \mid \bmod 3 > |W| \bmod 2\}$

ii) $L = \{w \mid W$ ends either with ab or ba$\}$. **(10 Marks)**

OR

2 a. Write a note on finite state transducers. **(07 Marks)**

b. Define DFSM? Minimize the following FSM. [Refer Fig.Q2(b)]

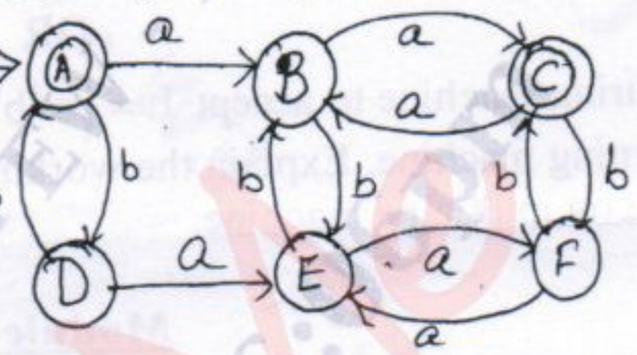

Fig.Q2(b) **(09 Marks)**

Module-2

3 a. Write the equivalent Regular Expression for the given Finite state machine. [Refer Fig.Q3(a)] **(08 Marks)**

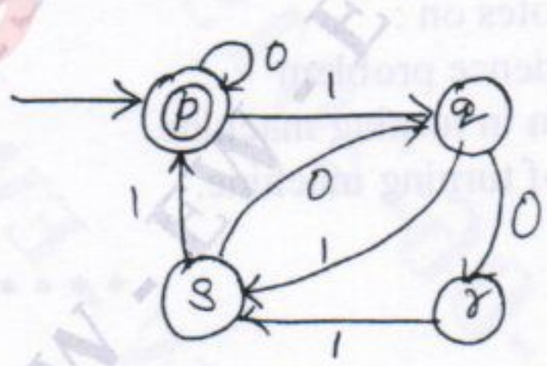

Fig Q3(a)

b. Write the Regular Expression for the following language.

i) $\{w \in \{a, b\}^*$ with atmost one a$\}$

ii) $\{w \in \{a, b\}^*$ does not end with ba$\}$

iii) $\{w \in \{0, 1\}^*$ has substring 001$\}$

iv) $\{w \in \{0, 1\}^* |W|$ is even$\}$. **(08 Marks)**

OR

4 a. State and prove the pumping theorem for regular language. **(08 Marks)**

b. Show that the language $L = \left\{a^n b^n \mid n \geq 0\right\}$ is not regular. **(08 Marks)**

Module-3

5 a. Define grammar. Write the CFG for the following language.
i) $L = \{ w \in \{a, b\}^* \mid n_a(w) = n_b(w) \}$
ii) $L = \{ a^i b^j \mid i = j+1 \}$. **(08 Marks)**

b. What is inherent ambiguity? Show that the language given is inherently amtriguous?
$L = \{ a^n b^n c^m \mid n, m \geq 0 \} \cup \{ a^n b^m c^n \mid n, m \geq 0 \}$. **(08 Marks)**

OR

6 a. Define PDA? Design PDA for the language $L = \{ a^n b^m a^n \mid n, m \geq 0 \}$. **(06 Marks)**

b. Convert the following language from CFG to PDA $L = \{ ww^R \mid w \in \{0, 1\}^* \}$. **(06 Marks)**

c. Convert the following CFG to CNF $E \rightarrow E + E \mid E * E \mid (E) \mid id$. **(04 Marks)**

Module-4

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

b. Prove that CFL are not closed under intersection, complement or difference? **(08 Marks)**

OR

8 a. Design a Turing machine to accept $L = \{ a^n b^n c^n \mid n \geq 0 \}$. **(08 Marks)**

b. Define a turning machine. Explain the working of a turning machine. **(05 Marks)**

c. Write a note on multitape machine. **(03 Marks)**

Module-5

9 Write a short notes on :
a. Growth rate of function **(05 Marks)**
b. Church-turning thesis **(06 Marks)**
c. Linear bounded automata. **(05 Marks)**

OR

10 Write a short notes on :
a. Post correspondence problem **(05 Marks)**
b. Halting problem in turning machine **(05 Marks)**
c. Various types of turning machine. **(06 Marks)**

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15CS54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following with example: (i) Alphabet (ii) String (iii) Language **(06 Marks)**

b. Draw a DFA to accept string of a's and b's ending with ab or ba. **(04 Marks)**

c. Draw a DFA to accept strings of a's and b's such that:
(i) Language has even number of a's and odd number of b's.
(ii) Language has not more than three a's. **(06 Marks)**

OR

2 a. Define different types of finite state machines.

b. Minimize the following Finite state machine. **(04 Marks)**

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

(06 Marks)

c. Convert the following ε - NFA to its equivalent DFA.

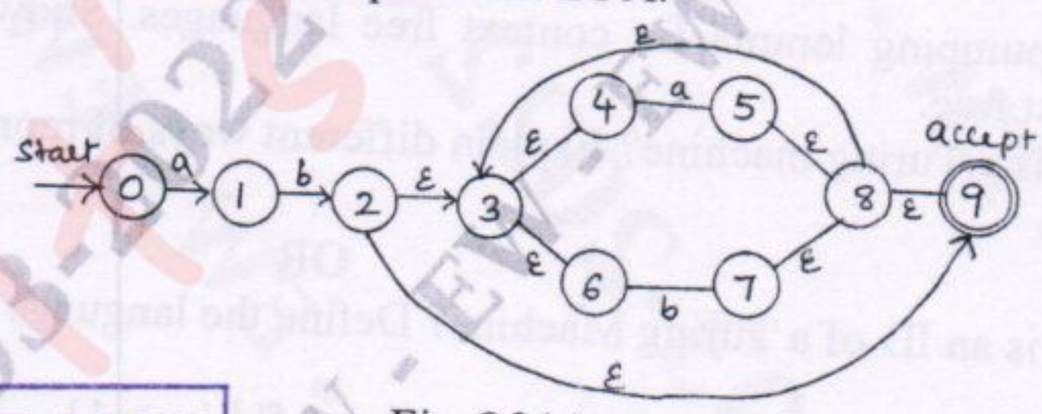

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. Define Regular expression and write R.E for the following language:
i) $L = \{a^{2n} b^{2m} \mid n \geq 0, m \geq 0\}$ (ii) $L = \{a^n b^m \mid m \geq 1, n \geq 1, nm \geq 3\}$ **(04 Marks)**

b. Explain different types of grammars. **(06 Marks)**

c. Obtain a FSM from the following grammar:
$S \rightarrow aT$
$T \rightarrow bT$
$T \rightarrow aW$
$W \rightarrow \varepsilon$
$W \rightarrow aT$
and obtain the equivalent regular expression. **(06 Marks)**

OR

4 a. Define a Regular grammar. Design regular grammars for the following languages:
(i) Strings of a's and b's ending with ab.
(ii) Strings of a's and b's having a substring aab. **(06 Marks)**

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

c. Show that $L = \{WW^R \mid W \in (0+1)^*\}$ is not regular using pumping lemma. **(04 Marks)**

Module-3

5 a. Define context free grammar. Write a context free grammar for the language
$L = \{a^{n+2} b^m \mid n \geq 0 \text{ and } m > n\}$ **(06 Marks)**

b. Define ambiguity of a grammar. Check whether the following grammar is ambiguous or not.
$S \rightarrow aS|X$
$X \rightarrow aX|a$ **(04 Marks)**

c. Simplify the following grammar:
$S \rightarrow aA|a|Bb|cC$
$A \rightarrow aB$
$B \rightarrow a|Aa$
$C \rightarrow cCD$
$D \rightarrow ddd$ **(06 Marks)**

OR

6 a. Define PDA. Obtain a PDA to accept $L = \{WW^R | W \in \{a, b\}^*\}$. Write the transition diagram. **(08 Marks)**

b. Convert the following grammar into equivalent PDA.
$E \rightarrow E + T$
$E \rightarrow T$
$T \rightarrow T * F$
$T \rightarrow F$
$F \rightarrow (E)$
$F \rightarrow id$ **(08 Marks)**

Module-4

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

b. What is a Turing machine? Explain different ways of representing Turing machines. **(08 Marks)**

OR

8 a. What is an ID of a Turing Machine? Define the language accepted by a Turing Machine. **(04 Marks)**

b. Design a TM to accept the language $L = \{a^n b^n \mid n \geq 1\}$ **(06 Marks)**

c. Explain Turing Machine Model. **(06 Marks)**

Module-5

9 a. What are the various techniques for TM construction? **(06 Marks)**

b. Derive the following: (i) Recursively enumerable language (ii) Decidable language. **(04 Marks)**

c. What is post correspondence problem? **(06 Marks)**

OR

10 a. What is halting problem? Explain. **(04 Marks)**

b. Define the following: (i) Quantum computer (ii) Class NP **(04 Marks)**

c. Explain Church Turing Hypothesis. **(08 Marks)**

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CBCS SCHEME

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15CS54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following terms with example:
(i) Length of a string (ii) Reversal (iii) Proper substring
(iv) Language (v) Power of an alphabet **(05 Marks)**

b. Design a FSM to accept set of all strings that either begins or ends or both with substring ab. **(05 Marks)**

c. Convert the given NDFSM to DFSM. (Refer Fig.Q1(c))

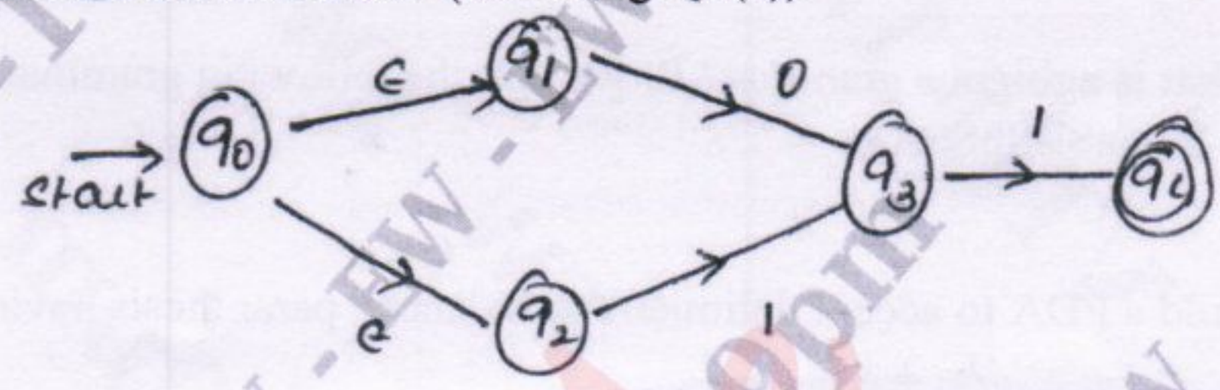

Fig.Q1(c) **(06 Marks)**

OR

2 a. Construct a minimized DFSM for the following: **(08 Marks)**

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

b. Define NDFSM and construct NDFSM for the following languages:
(i) To recognize the following set of strings abc, abd and aacd
(ii) $L = \{w | w \in abab^n \text{ or } aba^n \text{ where } n \geq 0\}$
(iii) $L = \{w | w = aba \text{ or } |w| \text{ is even}\}$ **(08 Marks)**

Module-2

3 a. Define Regular expression. Obtain a regular expression for the following languages:
(i) $L = \{w : |w| \text{ is even}\}$
(ii) $L = \{w : \text{in w the } 5^{th} \text{ character from right is a and either character is b}\}$
(iii) $L = \{w : w \text{ contains both aa and aba as sub string}\}$ **(06 Marks)**

b. Construct FSM for the following RE:
(i) ab (ii) b + (ab) (iii) (b + (ab))* (iv) (babb* + a)* (v) (b + ∈) (ab)* (a + ∈)
(10 Marks)

OR

4 a. Show that for every RE there is an equivalent FSM. **(05 Marks)**

b. Prove that the regular languages are closed under intersection and difference. **(06 Marks)**

c. Obtain RE from the following FSM. (Refer Fig.Q4(c))

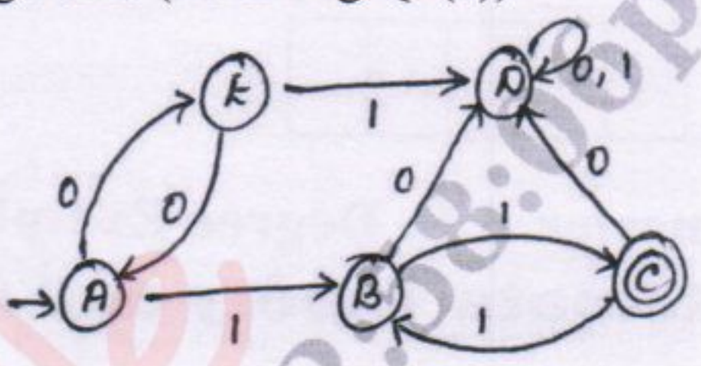

Fig.Q4(c) **(05 Marks)**

Module-3

5 a. Define context free grammar and write CFG for the following languages:
(i) $L = \{a^i b^j c^k : i + j = k, i \geq 0, j \geq 0\}$
(ii) $L = \{a^n b^m c^k : n + 2m = k\}$ **(06 Marks)**

b. Consider the grammar G, with productions:
$S \rightarrow AbB$
$A \rightarrow aA|\in$
$B \rightarrow aB|bB|\in$
Give the left most derivation, rightmost derivation and parse tree for the string aaabab. **(06 Marks)**

c. What is agbigous grammar? Prove that the following grammar is ambiqous on the string aab.
G: $S \rightarrow aS|aSbS|\in$ **(04 Marks)**

OR

6 a. Build a PDA to accept delimiters or balanced paranthesis having paranthesis {, (,) , }. **(08 Marks)**

b. Explain the following terms: (i) Pushdown Automata (PDA) (ii) Languages of a PDA **(04 Marks)**

c. Obtain a CFG for PDA M with the transitions:
$\delta(q_0, a, Z) = (q_0, AZ)$
$\delta(q_0, b, A) = (q_0, AA)$
$\delta(q_0, a, A) = (q_1, \in)$ **(04 Marks)**

Module-4

7 a. State and prove pumping Lemma for context free languages. **(06 Marks)**

b. Prove that $L = \{w \in \{a, b, c\}^* \text{ where } n_a(w) = n_b(w) = n_c(w)\}$ is not context free. **(04 Marks)**

c. Prove that the Context Free Languages are closed under, union and concatenation. **(06 Marks)**

OR

8 a. With a neat diagram, explain the working of a basic TM. **(06 Marks)**

b. Design a TM to accept the following language $L = \{0^n 1^n 2^n \mid n \geq 1\}$ **(10 Marks)**

Module-5

9 Write short notes on:
a. Multi Tape TM
b. Non Deterministic TM
c. Post Correspondence Problem **(16 Marks)**

OR

10 a. Prove that every Language accepted by a multitape TM is accepted by standard TM with single tape. **(06 Marks)**

b. Write note on: (i) Linear Bounded Automata (ii) Recursive Language **(10 Marks)**

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CBCS SCHEME

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

15CS54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. List the applications of Finite Automata. Design DFSM for following languages.
i) $L = \{W \mid\mid n_o \mid \bmod_2 = 0 \ \& \ |n_1| \bmod 3 = 0\}$.
ii) L = {strings of a's and b's which start with ab and ends with a}. **(10 Marks)**

b. Define Finite State Transducers. Obtain and equivalent Moore machine for the Mealy machine given below. **(06 Marks)**

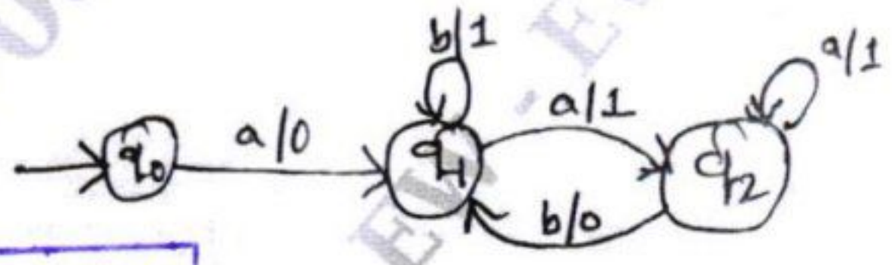

Fig. Q1(b)

OR

2 a. Define Power of an Alphabet. Consider the DFSM given below with accepting states (D, F, G) and compute. **(08 Marks)**

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

i) Distinguishable & Equivalent States ii) Minimization of Finite State Machine.

b. Define eps ( ). Obtain an equivalent DFSM for Finite Automata given below. **(08 Marks)**

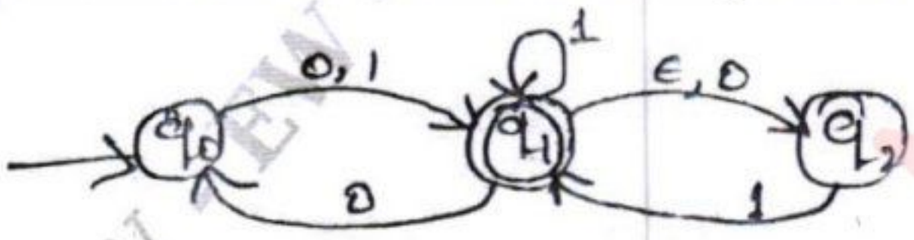

Fig. Q2(b)

Module-2

3 a. Define Regular Expression. Construct the Regular expression for the languages given below
i) $L = \{a^n b^m \mid n, m \geq 1, mn \geq 3\}$ ii) $L = \{a^n b^m \mid m + n \text{ is even}\}$
iii) L = {Strings of 0's & 1's which does not contain two consecutive 0's and ends with 0}. **(08 Marks)**

b. State and prove the pumping Lemma for Regular Languages. Prove that, the language $L = \{a^n b^m c^n \mid n, m \geq 0\}$ is not regular. **(08 Marks)**

OR

4 a. Obtain Regular expression for Finite State Machine given below and give the language defined by Regular expression. **(08 Marks)**

Fig. Q4(a)

b. List the closure properties of Regular Languages construct the Regular Grammar for following : i) $L = \{(01)^* 101 (0 + 1)^*\}$ ii) $L = \{a^{n+1} b^{2m+1} \mid n, m \geq 0\}$ iii) $L = \{(01 + 1)^* (0 + 10)^*\}$. **(08 Marks)**

Module-3

5 a. Define CFG. Construct CFG for the languages given below :
i) $L = \{W \mid n_a (W) = n_b (W)\}$ ii) $L = \{a^{2n+1} b^m c^m c^{2n} \mid n, m \geq 0\}$. **(08 Marks)**

b. Define CNF. Design PDA for the language $L = \{0^n b^m 1^{2n} \mid n, m \geq 0\}$. Write the Instantaneous Description for the string 0bb11. **(08 Marks)**

OR

6 a. Consider the Grammar
$E \rightarrow E + E \mid E - E \mid E * E \mid E/E \mid (E) \mid I$
$I \rightarrow 0 \mid 1 \mid a \mid b \mid Ia \mid Ib \mid I0 \mid I1$
and compute the following for input string (a1 + b0 * 00).
i) LMD ii) RMD iii) Parse Tree iv) Is this ambiguous? Justify your answer. **(08 Marks)**

b. List out the simplification techniques of CFG. Explain PDA and obtain an equivalent PDA for CFG given below : $S \rightarrow a \mid b \mid a S b \mid b S a$. **(08 Marks)**

Module-4

7 a. List the Closure properties of CFLs and prove that language $L = \{a^{2n} b^n c^{2n} \mid n \geq 0\}$ is not context free language. **(08 Marks)**

b. Define TM. Explain working of TM with neat diagram. **(08 Marks)**

OR

8 a. Design and construct TM to accept the language L = {W | W is balance parenthesis}. Show the moves made by TM for string W = (( ) ( )). **(08 Marks)**

b. List the techniques for TM construction. Explain the concept of string membership in CFL using context free grammar and Push Down Automata. **(08 Marks)**

Module-5

9 a. List the variants of TM. Prove that for every language accepted by multi tape TM is accepted by some Single tape TM. **(08 Marks)**

b. Define Linear Bounded Automata (LBA). Explain the model of LBA with neat diagram and state the relation between LBA and context sensitive language. **(08 Marks)**

OR

10 a. State the definition of Algorithm by Church – Turing. Explain the Quantum computers. **(08 Marks)**

b. Define P, NP classes with respect to TM. Explain post correspondence problem and prove that PCP with two list $x = (01, 1, 1)$; $y = (01^2, 10, 1^1)$ has no solution. **(08 Marks)**

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CBCS SCHEME

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

15CS54

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following terms with examples:
(i) Alphabet (ii) Length of string (iii) prefix **(05 Marks)**

b. Build a DFSM for the language:
$L = \{\omega \in \{a, b\}^* : \text{no two consecutive characters are the same}\}$ **(05 Marks)**

c. For the following NDFSM, use ndfsmtodfsm to construct an equivalent DFSM. Begin by showing the value of eps(q) for each state q.

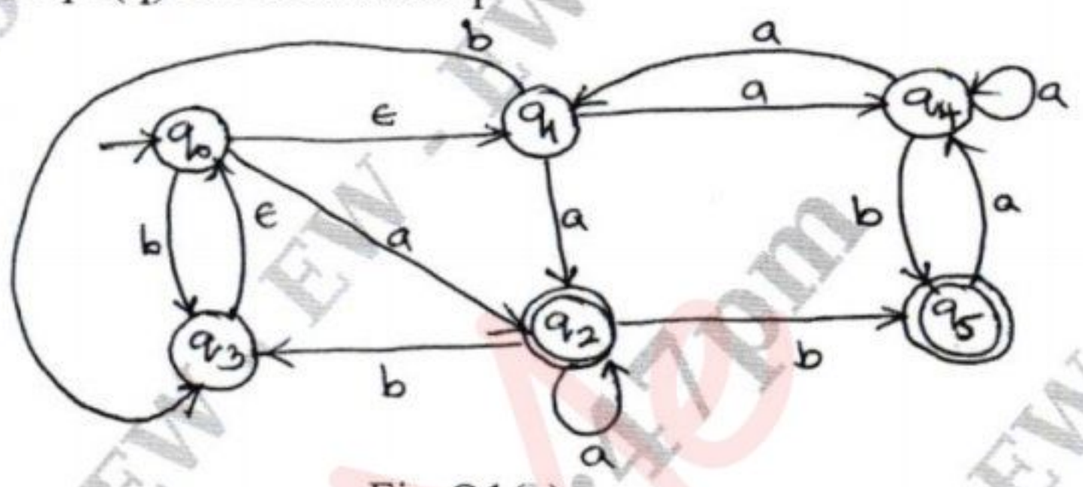

Fig.Q1(c) **(06 Marks)**

OR

2 a. Explain the Machine-Based Hierarchy of Language classes. **(05 Marks)**

b. Build a nondeterministic FSM for the language $L = \{\omega \in \{a, b\}^* : \omega = bab \text{ or } |\omega| \text{ is odd}\}$. **(05 Marks)**

c. Minimize the DFSM.

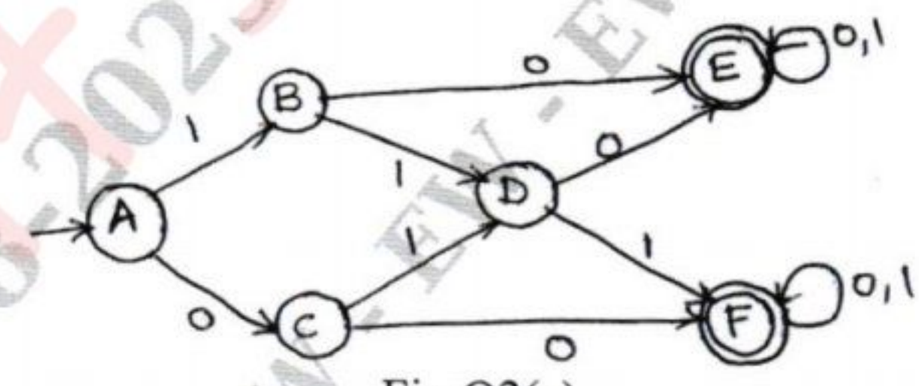

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. Define Regular Expression and write a RE to describe each of the following language:
(i) $L = \{a^n b^m : n \geq 4, m \leq 3\}$
(ii) $L = \{\omega \in \{a, b\}^* : \omega \text{ has both aa and bb as substrings}\}$ **(05 Marks)**

b. Show that Regular Languages are closed under complement. **(05 Marks)**

c. Build a Regular Expression from the given FSM.

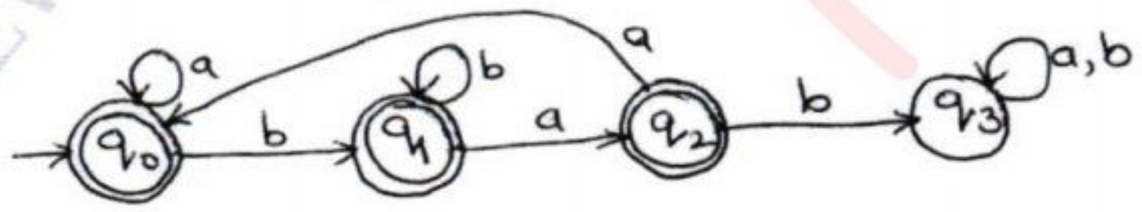

Fig.Q3(c) **(06 Marks)**

OR

4 a. Show a regular grammar for the FSM.

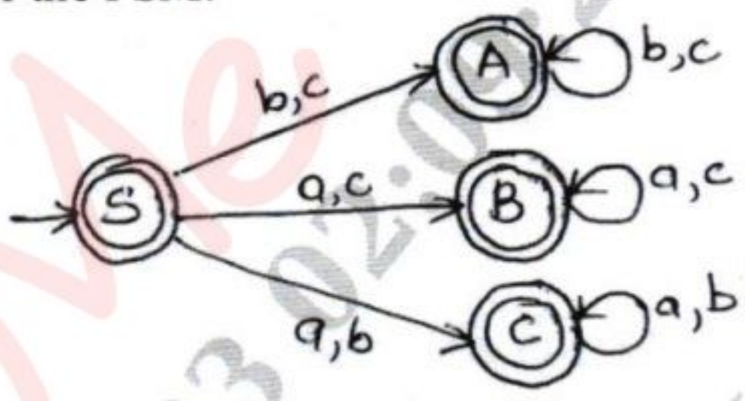

Fig.Q4(a) **(05 Marks)**

b. Build an FSM from the RE $(a^* \cup b^* c^*)^*$. **(05 Marks)**

c. State and prove the pumping lemma for Regular Languages. **(06 Marks)**

Module-3

5 a. Define context free grammar. Design a CFG for the language $L = \{a^n b^m c^m d^{2n} : n, m \geq 0\}$. **(05 Marks)**

b. Consider the CFG with productions

$E \rightarrow E + T \mid T$

$T \rightarrow T * F \mid F$

$F \rightarrow (E) \mid 0 \mid 1$

Write the leftmost derivation, rightmost derivation and a parse tree for the string $0 + 1 * 1$. **(05 Marks)**

c. Design a PDA for the language $L = \{a^n b^{2n} : n \geq 0\}$ **(06 Marks)**

OR

6 a. Prove whether the given grammar is ambiguous grammar or not.

$S \rightarrow aB|bA$

$A \rightarrow aS|bAA|a$

$B \rightarrow bS \mid aBB \mid b$ for the string aab. **(05 Marks)**

b. Define Chomsky normal form. Apply the normalization algorithm to convert the grammar to CNF.

$S \rightarrow ABC$

$A \rightarrow aC \mid D$

$B \rightarrow bB \mid \in \mid A$

$C \rightarrow Ac \mid \in \mid Cc$

$D \rightarrow aa$ **(05 Marks)**

c. Design a PDA for the language $L = \{a^i b^j c^k : i + j = k, i \geq 0, j \geq 0\}$. **(06 Marks)**

Module-4

7 a. Prove that the language $L = \{a^n b^n c^n : n \geq 1\}$ is not context free. **(05 Marks)**

b. Show that context free languages are closure under union, concatenation and kleene star. **(05 Marks)**

c. Design a Turing Machine to recognize all strings consisting of an even number of 1's. **(06 Marks)**

OR

8 a. Explain technique used for TM construction. **(05 Marks)**

b. What is the relationship between DCFL's and the L's that are not inherently ambiguous? Explain. **(05 Marks)**

c. Design a Turing Machine that accepts $L = \{a^n b^n : n \geq 1\}$. Obtain the instantaneous description for the string aabb. **(06 Marks)**

Module-5

9 a. Let $f(n) = 4n^3 + 5n^2 + 7n + 3$. Prove that $f(n) = O(n^3)$. **(05 Marks)**

b. Write a note on quantum computers. **(05 Marks)**

c. Find the running time for the Euclidean algorithm for evaluating gcd(a, b) where a and b are positive integers expressed in binary representation. **(06 Marks)**

OR

10 a. Explain the multi-tape TM. **(05 Marks)**

b. Explain the model of Linear Bounded Automata. **(05 Marks)**

c. Define PCP. Does the PCP with two lists $x = (b, bab^3, ba)$ and $y = (b^3, ba, a)$ have a solution. **(06 Marks)**

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