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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.***

Module-1

1 a. Define the following terms with examples :
i) Alphabet ii) String iii) Language iv) Concatenation at Languages
v) Power of an Alphabet. **(10 Marks)**

b. Define DFSM. Design DFSM
i) To accept strings having Even number of a's and even number b's
ii) To accept binary numbers divisible by 5. **(10 Marks)**

OR

2 a. Convert the following NDFSM of DFSM. [Refer Fig Q2(a)].

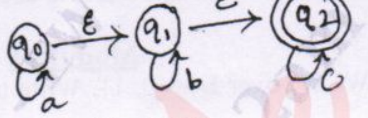

Fig Q2(a) **(08 Marks)**

b. Minimize the following DFSM by indentifying Distinguishable and Non-distinguishable states.

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

(12 Marks)

Module-2

3 a. Define Regular Expression. Write RE for the following Languages.
i) Strings of 0's and 1's ending with three consecutive zeroes.
ii) Strings of a's and b's having substring aa. **(10 Marks)**

b. Write DFSM to accept intersection of Languages $L_1 = (a + b)^*a$ and $L_2 = (a + b)^*b$ **(10 Marks)**

OR

4 a. Using Kleen's theorem, prove that for any Regular Expression R, their exits a finite automata $M = (Q, \Sigma, \delta, q_0, F)$ which accepts L(R). **(10 Marks)**

b. State and prove pumping Lemma for Regular Languages. Show that the Language $L = \{ww^r : w \in (0, 1)^*\}$ is not regular. **(10 Marks)**

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-3

5 a. Define Context Free Grammar. Design CFG for the following Languages.
   i) $L_1 = \{w : |w| \text{ Mod } 3 = 0\}$ over $\Sigma = \{a\}$
   ii) $L_2 = \{a^n b^m c^k : m = n + k\}$ over $\Sigma = \{a, b, c\}$ **(10 Marks)**

b. Define Ambiguity. Consider the grammar
   $E \rightarrow E + E \mid E * E \mid (E) \mid id$
   Find Leftmost and Rightmost derivations and parse tree for the string id + id * id, show that the grammar is ambiguous. **(10 Marks)**

OR

6 a. What is Chomsky Normal Form of CFG? Convert the following grammar to CNF.
   $S \rightarrow ABC \mid BaB$
   $A \rightarrow aA \mid BaC \mid aaa$
   $B \rightarrow bBb \mid a \mid D$
   $C \rightarrow CA \mid AC$
   $D \rightarrow \varepsilon$
   Eliminate ε - productions, Unit productions and useless symbols if any before conversion. **(10 Marks)**

b. What is NPDA? Design NPDA for Language $L = \{a^n b^n \mid n \geq 1\}$. Draw transition diagram. Write sequence of moves made by NPDA to accept the string aaabbb. **(10 Marks)**

Module-4

7 a. Design TM for WCW^R over $\Sigma = \{0, 1\}$. Write transition diagram, and ID for w = 101C101 **(14 Marks)**

b. Explain : i) Multitape ii) Non-deterministic TM **(06 Marks)**

OR

8 a. Define Turning Machine. Explain the working of Turning Machine. **(06 Marks)**

b. Design Turning machine to accept the Language $L = \{0^n 1^n 2^n | n >= 0\}$. Draw the transition diagram. Write sequence of moves made by TM for string 001122. **(14 Marks)**

Module-5

9 a. Explain Halting problem in Turning machine. **(07 Marks)**

b. Write applications of Turning Machine. **(06 Marks)**

c. Explain Recursively Enumerable Languages. **(07 Marks)**

OR

10 a. Explain Quantum Computers. **(07 Marks)**

b. Explain P and NP classes. **(07 Marks)**

c. Explain Church Turning Thesis. **(06 Marks)**

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USN

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

b. Design a DFSM to accept each of the following language:
i) $L = \{w \in \{a, b\}^*$; w has all strings that ends with sub string abb }
ii) $L = \{w$; where $|w|$ mod 3 = 0 where $\Sigma = \{a\}\}$
iii) $L = \{w \in \{a, b\}^*$ every a region in w is of even length.} **(09 Marks)**

c. Construct an equivalent DFA from the following given NFA using subset construction method. (Refer Fig.Q.1(c)) **(07 Marks)**

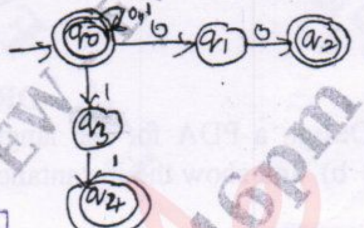

Fig.Q.1(c)

OR

2 a. Construct a minimum state automation equivalent to the FA given table

States	0	1
→q_0	q_1	q_5
q_1	q_6	q_2
(q_2)	q_0	q_2
q_3	q_2	q_6
q_4	q_7	q_5
q_5	q_2	q_6
q_6	q_6	q_4
q_7	q_6	q_2

(10 Marks)

b. Consider the following NFA with ∈-moves construct on equivalent DFA. **(10 Marks)**

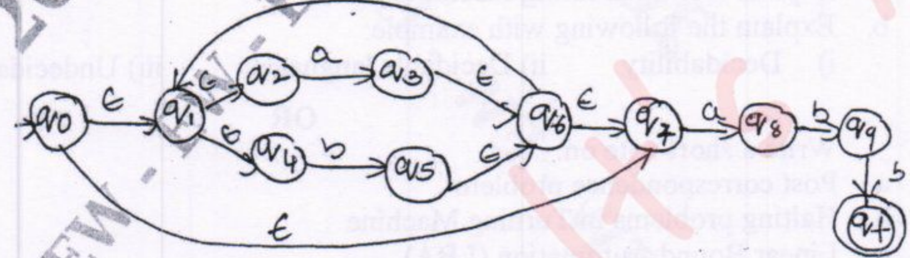

Fig.Q.2(b)

Module-2

3 a. Define Regular expression. Write RE 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) $L = \{a^{2n} b^{2m} | n \geq 0, m \geq 0\}$ (10 Marks)

b. Construct an $\in$ - NFA for the regular expression $0 + 01^*$ (05 Marks)
c. Construct on FA for the regular expression $10 + (0 + 11)0^*1$ (05 Marks)

OR

4 a. State and prove pumping lemma theorem for regular languages. (08 Marks)
b. Prove that $L = \{a^p | p \text{ is a prime}\}$ is not a regular. (08 Marks)
c. List out closure properties of regular sets. (04 Marks)

Module-3

5 a. Define CFG. Write a CFG to specify
i) all string over {a, b} that are even and odd palindromes.
ii) $L = \{a^n b^{2n} \text{ over } \Sigma = \{a, b\} n \geq 1\}$ (10 Marks)

b. Write the procedure for removal of $\in$-productions. Simplify the following grammar.
$S \rightarrow aA \mid aBB$
$A \rightarrow aAA \mid \in$
$B \rightarrow bB \mid bbC$
$C \rightarrow B$ (10 Marks)

OR

6 a. Define PDA. Design a PDA for the language that accepts the string with $n_a(w) < n_b(w)$ where $w \in | (a + b)^*$ and show the instantaneous description of the PDA on input abbab. (10 Marks)

b. What is CNF and GNF? Convert the following grammar into GNF.
$S \rightarrow AA | a$
$A \rightarrow SS | b$ (10 Marks)

Module-4

7 a. With a neat diagram, explain variant of turning machine. (10 Marks)
b. Construct a Turning machine that accept the language $0^n, 1^n$ where $n > 1$ and draw transition graph for Turning Machine. (10 Marks)

OR

8 a. Define Turning Machine with its tuples. (04 Marks)
b. Explain the working principle of Turning Machine with diagram. Design a Turing Machine to accept strings formed on {0, 1} and ending with 000. Write transition diagram and ID for w = 101000. (16 Marks)

Module-5

9 a. Explain restricted turing machines. (08 Marks)
b. Explain the following with example:
i) Decidability ii) Decidable languages iii) Undecidable languages. (12 Marks)

OR

10 Write a short note on:
a. Post correspondence problem
b. Halting problems in Turning Machine
c. Linear Bound Automation (LBA)
d. Classes of P and NP (20 Marks)

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18CS54

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 an example i) Alphabet ii) Power of an alphabet iii) String iv) String concatenation v) language. **(05 Marks)**

b. Explain the hierarchy of language classes in automata theory with diagram. **(05 Marks)**

c. Design DFSM for each of the following language.

i) $L = \{\omega \in \{0,1\}^* : \omega \text{ does not end in } 01\}$

ii) $L = \{\omega \in \{a,b\}^* :$ every a in ω is immediately preceded and followed by b$\}$. **(10 Marks)**

OR

2 a. Use MiNDFSM algorithm to minimize M given in Fig Q2(a).

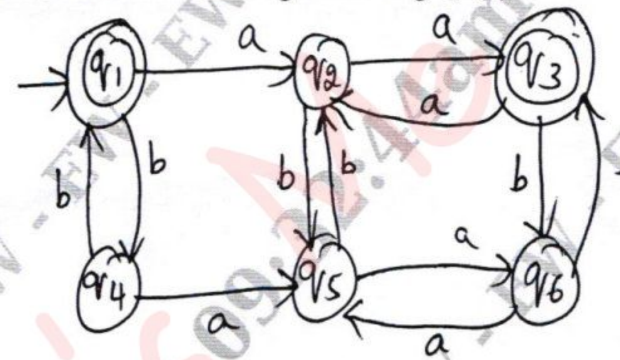

Fig Q2(a) **(08 Marks)**

b. Convert the following NDFSM given in Fig Q2(b) to its equivalent DFSM.

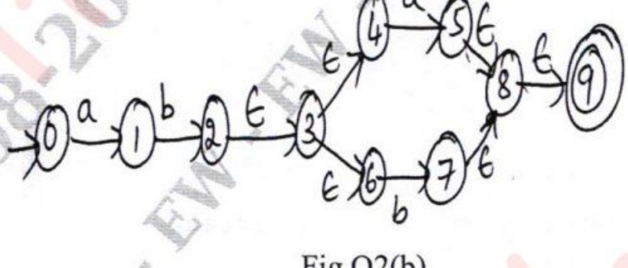

Fig Q2(b) **(08 Marks)**

c. Design a mealy machine that takes binary number as input and produces 2's complement of the number as output. **(04 Marks)**

Module-2

3 a. Define Regular expression. Write regular expression for the following language.

i) $L = \{0^n 1^m \mid m \geq 1, n \geq 1, mn \geq 3\}$

ii) $L = \{\omega \in \{a, b\}^* :$ string with atmost one pair of consecutive a's$\}$ **(08 Marks)**

b. Obtain NDFSM for the regular expression $(a^* \cup ab)(a \cup b)^*$. **(05 Marks)**

c. Build a regular expression for the given FSM in Fig Q3(c).

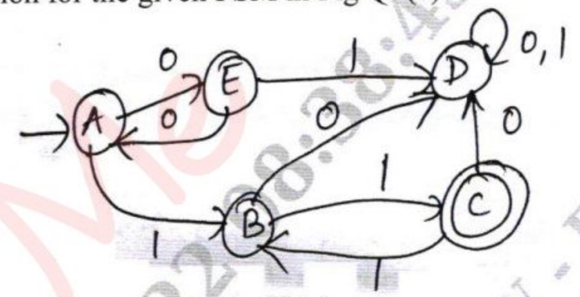

Fig Q3(c) **(07 Marks)**

OR

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

b. Prove that regular languages are closed under complement. **(05 Marks)**

c. Write regular expression, regular grammer and FSM for the languages
$L = \{ \omega \in \{a, b\}^* : w \text{ ends with pattern aaaa}\}$. **(07 Marks)**

Module-3

5 a. Define Context Free Grammer (CFG). Write CFG for the following languages
$L = \{0^m 1^m 2^n : m \geq 1, n \geq 0\}$. **(05 Marks)**

b. What is ambiguity in a grammar? Eliminate ambiguity from balanced parenthesis grammar? **(08 Marks)**

c. Simplify the grammar by removing productive and unreachable symbols
$S \rightarrow AB|AC$
$A \rightarrow aA\,b|\in$
$B \rightarrow bA$
$C \rightarrow bCa$
$D \rightarrow AB$ **(07 Marks)**

OR

6 a. Define PDA and design PDA to accept the language by final state method. **(07 Marks)**
$L(M) = \{ \omega C \omega^R \mid \omega \in (a \cup b)^* \text{ and } \omega^R \text{ is reverse of } \omega\}$

b. Convert the following grammar to CNF
$S \rightarrow ASB|\in$
$A \rightarrow a\,AS|a$
$B \rightarrow SbS|A|bb$ **(08 Marks)**

c. Consider the grammar
$E \rightarrow E + E|E * E|(E)|id$
Construct LMD, RMD and parse tree for the string (id + id * id). **(05 Marks)**

Module-4

7 a. Define Turing Machine (TM). Design a TM for language
$L = \{0^n 1^n \mid n \geq 1\}$. Show that the string 0011 is accepted by ID. **(10 Marks)**

b. Explain multiple TM with a neat diagram. **(05 Marks)**

c. Explain any two techniques for TM construction. **(05 Marks)**

OR

8 a. Design a TM for the language $L = \{1^n 2^n 3^n \mid n \geq 1\}$ show that the string 11 22 33 is accepted by ID. **(12 Marks)**

b. Demonstrate the model of Linear Bounded Automata (LBA) with a neat diagram. **(08 Marks)**

Module-5

9 a. Show that A_{DFA} is decidable. **(05 Marks)**

b. Define Post Correspondence Problem (PCP). Does the PCP with two list $x = (b, bab^3, ba)$ $y = (b^3, ba, b)$ have a solution. **(08 Marks)**

c. Explain quantum computation. **(07 Marks)**

OR

10 a. Prove the A_{TM} is undecidable. **(05 Marks)**

b. Does the PCP with two list x = (0, 01000, 01) y = (000, 01, 1) have a solution. **(05 Marks)**

c. State and explain Church Turning Thesis in detail. **(10 Marks)**

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CBCS SCHEME

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

18CS54

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 alphabet, powers of an alphabet string, string concatenation and languages. **(10 Marks)**

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

i) L = {W∈ {0.1}* : W is ending with 011}

ii) L = {W∈ {0.1}* : W has odd numbers of a's and even numbers of b's} **(10 Marks)**

2 a. Convert the following NDFSM to DFSM:

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

(10 Marks)

b. 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

(10 Marks)

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

i) To accept strings of a's and b's such that third symbol from the right is 'a' and fourth symbol from the right is 'b'.

ii) L = {a^nb^m; n ≥ 4, m ≤ 3} **(10 Marks)**

b. Build a regular expression from the following FSM (Finite State Machine). **(06 Marks)**

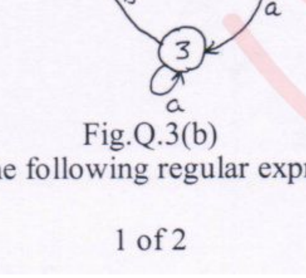

Fig.Q.3(b)

c. Write an equivalent NDFSM for the following regular expression $a(a^* + b^*)^*b$. **(04 Marks)**

4 a. Show that regular languages are closed under complement and intersection. (10 Marks)
b. State and prove pumping lemma theorem for regular languages. And show that the language $L = \{WW^R : W \in \{0, 1\}^*$ is not regular$\}$. (10 Marks)

5 a. Define CFG (Context Free Grammar). Design CFG for the languages.
i) $L = \left\{O^{2n}1^m \middle| n >= 0, m >= 0\right\}$
ii) $L = \left\{O^i1^j2^k \middle| i = j \text{ or } j = k\right\}$ (10 Marks)
b. Define Ambiguity. Is the following grammar ambiguous? Give reason.
$S \rightarrow iCts|iCtSeS|a$
$C \rightarrow b$ (10 Marks)

6 a. Define CNF (Chomsky Normal Form). Convert the following CFG to CNF.
$S \rightarrow aACa,\ A \rightarrow B|a\ ,\ B \rightarrow C|c\ ,\ C \rightarrow cC|\varepsilon$ (10 Marks)
b. Define PDA (Push Down Automata). Design a PDA to accept the following language, $L = \{a^nb^n : n > = 0\}$. Draw the transition diagram for the constructed PDA. Show the ID's for the string aaabbb. (10 Marks)

7 a. Define a Turing Machine. Explain the working of a Turing Machine. (08 Marks)
b. Design a Turing Machine to accept $L = \{0^n1^n2^n | n >= 0\}$. Draw the transition diagram. Show the moves made for string 001122. (12 Marks)

8 a. Design a TM for addition of 2 numbers (2 + 3) with transition diagram and ID for the same. (14 Marks)
b. Define and differentiate DTM and NDTM. (06 Marks)

9 a. Explain post correspondence problem. (08 Marks)
b. Explain Halting problem in Turing Machine. (08 Marks)
c. Write a note on Church Turing Hypothesis. (04 Marks)

10 a. Explain three variants of Turing Machine. (12 Marks)
b. Write a note on Quantum Computation. (08 Marks)

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Model Question Paper-1 with effect from 2019-20 (CBCS Scheme)

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Fifth Semester B.E. Degree Examination

Automata Theory and Computability

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

Module – 1

Q.1

(a) Define the following terms with examples: Alphabet, Power of an alphabet, String, Concatenation and Languages. — 10

(b) Define DFSM. Design a DFSM to accept each of the following languages: — 10

i) L= {w∈{0,1}* : w has 001 as a substring}

ii) L={ w∈{0,1}* : w has even number of a's and even number of b's}

OR

Q.2

(a) Convert the following NDFSM to DFSM. — 10

δ	ϵ	a	b	c
->p	{q,r}	{}	{q}	{r}
q	{}	{p}	{r}	{p,q}
*r	{}	{}	{}	{}

(b) Define distinguishable and indistinguishable states. Minimize the following DFSM. — 10

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

Module – 2

Q.3

(a) Define Regular expression. Write the regular expression for the following languages: — 10

i) Representing for strings of a's and b's having odd length.

ii) To accept strings of a's and b's such that third symbol from the right is a and fourth symbol from the right is b.

(b) Use the fsmtoregexheuristic algorithm to construct a regular expression that describes L(M). — 10

δ	a	b
->*1	2	{}
*2	3	1
3	3	1

OR

Q.4

(a) Show that regular languages are closed under complement and intersection. — 8

(b) State and prove pumping lemma theorem for regular languages. And show that the language L={ww^r; w∈{0,1}*) is not regular. — 12

Module – 3			
Q.5	**(a)**	Define CFG. Design CFG for the languages i) $L=\{0^{2n}1^{m} \mid n>=0,m>=0\}$ ii) $L=\{0^{i}1^{j}2^{k} \mid i=j \text{ or } j=k\}$	10

	(b)	Define Ambiguity. Consider the grammar E->E+E|E*E|(E)|id. Find the leftmost, rightmost derivations and parse trees for the string id+id*id. And show that this grammar is ambiguous.	10
OR			
Q.6	**(a)**	Define CNF. Convert the following CFG to CNF. S->aACa A->B/a B->C/c C->cC/ϵ	10
	(b)	Define PDA. Design a PDA to accept the following language. L={$a^n b^n$; n>=0}. Draw the transition diagram for the constructed PDA. Show the ID's for the string aaabbb.	10
Module – 4			
Q.7	**(a)**	With a neat diagram, explain variants of Turing Machines	10
	(b)	Explain Language Acceptability and Design of Turing Machines.	8
OR			
Q.8	**(a)**	Define a Turing machine. Explain the working of a Turing machine.	8
	(b)	Design a Turing machine to accept L={$0^n 1^n 2^n$| n>=0}. Draw the transition diagram. Show the moves made for string aabbcc.	12
Module – 5			
Q.9	**(a)**	Explain post correspondence problem.	7
	(b)	Explain Halting problem in Turing machine.	6
	(c)	Explain recursively enumerable language.	7
OR			
Q.10	**(a)**	Explain Church Turing thesis.	7
	(b)	Explain Quantum computer.	6
	(c)	Explain Growth rate of function.	7

Table showing the Bloom's Taxonomy Level, Course Outcome and Programme Outcome				
Question		**Bloom's Taxonomy Level attached**	**Course Outcome**	**Programme Outcome**
Q.1	(a)	L1	1	1,12
	(b)	L1,L3	2	1,2,12
	(c)			
Q.2	(a)	L3	2	1,2,12
	(b)	L1,L3	2	1,2,12
	(c)			
Q.3	(a)	L2	3	1,2,3,4,12
	(b)	L3	3	1,2,3,4,12
	(c)			
Q.4	(a)	L2	3	1,2,3,4,12
	(b)	L2,L3	3	1,2,3,4,12
	(c)			
Q.5	(a)	L1,L3	3	1,2,3,4,12
	(b)	L2	3	1,2,3,4,12
	(c)			
Q.6	(a)	L1,L3	4	1,2,3,4,12
	(b)	L1,L3	3	1,2,3,4,12
	(c)			
Q.7	(a)	L2,L3	3	1,2,3,4,12
	(b)	L2	3	1,2,3,4,12
	(c)			
Q.8	(a)	L2	4	1,2,3,4,12
	(b)	L3	4	1,2,3,4,12
	(c)			
Q.9	(a)	L2	5	1,2,12
	(b)	L2	5	1,2,12
	(c)	L2	5	1,2,12
Q.10	(a)	L2	5	1,2,12
	(b)	L2	5	1,2,12
	(c)	L2	5	1,2,12

Bloom's Taxonomy Levels	**Lower order thinking skills**		
	Remembering(knowledge):L_1	Understanding Comprehension): L_2	Applying (Application): L_3
	Higher order thinking skills		
	Analyzing (Analysis): L_4	Valuating (Evaluation): L_5	Creating (Synthesis): L_6

CBCS SCHEME

USN | | | | | | | | | | | **18CS54**

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 terms with example
i) Alphabet ii) Power of an alphabet iii) Language **(06 Marks)**

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

c. Define deterministic finite state machine. Design DFSM
i) To accept strings having odd number of a's and odd number of b's
ii) To accept strings having number of a's divisible by 5 and number of b's divisible by 3. **(10 Marks)**

OR

2 a. Convert the following NDFSM [Refer Fig Q2(a)] to its equivalent DFSM.

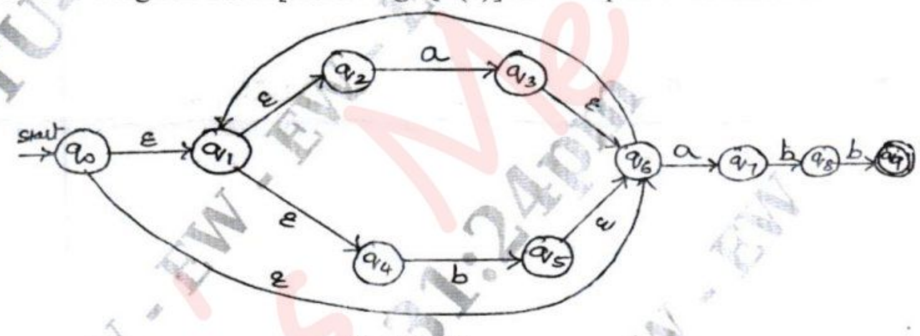

Fig Q2(a) **(10 Marks)**

b. Define distinguishable and indistinguishable states minimize the following DFSM shown in Table Q2(b)

	δ	a	b
→	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

(10 Marks)

Module-2

3 a. Define regular expression. Obtain a regular expression for the following :
i) $L = \{a^n b^m \mid n \geq 4, m \leq 3\}$
ii) $L = \{w : n_a(w) \bmod 3 = 0 \text{ where } w \in (a, b)^*\}$
iii) $L = \{w : \text{strings ends with ab or ba where } w \in \{a, b\}^*\}$
iv) $L = \{a^{2n} b^{2m} \mid n \geq 0, m \geq 0\}$ **(10 Marks)**

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.

b. Consider the DFSM shown below

States	0	1
→ q_1	q_2	q_1
q_2	q_3	q_1
* q_3	q_3	q_2

Obtain the regular expression $R_{ij}^{(0)}$, $R_{ij}^{(1)}$ and simplify the regular expression as much as possible. **(10 Marks)**

OR

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

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

Module-3

5 a. Define context free grammar. Design CFG for the following language.

i) $L = \{0^i 1^j \mid i \# j, i \geq 0, j \geq 0\}$ ii) $L = \{a^n b^m \mid n \geq 0, m > n\}$ **(10 Marks)**

b. Define Ambiguity consider the grammar

$E \rightarrow E + E \mid E - E \mid E^* E \mid E/E \mid a/b$

Find Leftmost and Rightmost derivation and parse tree for the string **a + b** * a + b, show that the grammar is ambiguous. **(10 Marks)**

OR

6 a. Define Chomsky normal form and Greibach normal form. Convert the following grammar to CNF

$S \rightarrow OA \mid 1B$

$A \rightarrow OAA \mid 1S \mid 1$

$B \rightarrow 1BB \mid 0S \mid 0$ **(10 Marks)**

b. Define a PDA. Obtain PDA to accept the language $L = \{wcw^R / w \in \{a, b\}^*$ where w^R is reverse of w by a final state. Draw transition diagram. Write sequence of moves made by PDA to accept the string aabcbaa. **(10 Marks)**

Module-4

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

b. Design turning machine to accept the language $L = \{a^n b^n c^n \mid n \geq 1\}$. Draw the transition diagram and shown the moves made by turing machine for the string aabbcc. **(14 Marks)**

OR

8 a. Explain various technique used for construction of turing machine. **(05 Marks)**

b. Explain the following ;

i) Multitape Turing machine ii) Non-deterministic Turing machine

iii) Linear bounded automata **(15 Marks)**

Module-5

9 a. Explain halting problem in Turing machine prove that

$HALT_{TM} = \{(M, W) \mid$ The Turing machine M halts on input w$\}$ is undecidable. **(10 Marks)**

b. Define decidable language prove that DFA is decidable language (A_{DFA} is decidable) **(10 Marks)**

OR

10 a. Explain quantum computers **(06 Marks)**

b. Explain Church-Turing Thesis **(07 Marks)**

c. Explain post correspondence problem. **(07 Marks)**

CBCS SCHEME

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18CS54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023

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 DFSM. Design DFSM

i) To accept strings over {a, b} such that each block of 5 (length five) consecutive symbols have atleast two a's.

ii) To accept $L = \{\omega(ab + ba) \mid \omega \in \{a, b\}^*\}$

iii) To accept $L = \{\omega bab \mid \omega \in \{a, b\}^*\}$ **(10 Marks)**

b. Define distinguishable and indistinguishable states. Minimize the following DFSM.

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

(10 Marks)

OR

2 a. Convert the following NDFSM to DFSM. [Refer Fig.Q2(a)].

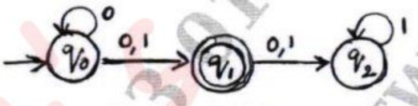

Fig.Q2(a) **(08 Marks)**

b. Explain the simulators for Finite State Machine. **(06 Marks)**

c. Design

(i) Mealy Machine that accepts the string that ends either with aa or bb and $\Sigma = \{a, b\}$

(ii) Moore Machine that produces 'A', 'B' and 'C' depending on inputs that end with '10', '11' and others respectively. **(06 Marks)**

Module-2

3 a. Build regular expression from the following FSM. [Refer Fig.Q3(a)].

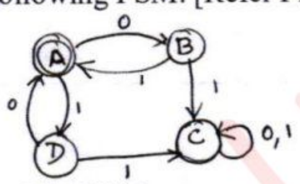

Fig.Q3(a) **(05 Marks)**

b. State and prove pumping Lemma theorem for regular languages. Show that $L = \{a^n b^n \mid n \geq 0\}$ is not Regular. **(10 Marks)**

c. Show that regular languages are closed under complement and intersection. **(05 Marks)**

OR

4 a. Obtain Regular Expression for the following languages.
(i) $L = \{ a^n b^m c^p \mid n \le 4, m \ge 2, p \le 2 \}$
(ii) $L = \{ \omega : |\omega| \bmod 3 = 0 \ \& \ \omega \in \{a, b\}^* \}$
(iii) $L = \{ a^n b^m \mid m + n \text{ is even} \}$ **(08 Marks)**

b. Prove Kleen's theorem – Any language that can be defined with a regular expression can be accepted by some FSM and so is regular. **(08 Marks)**

c. Obtain NDFSM for the following regular expression $(a + b)^*$ abb. **(04 Marks)**

Module-3

5 a. Design a PDA for the language
$L = \{ \omega c \omega^R \mid \omega \in (a, b)^* \text{ where } \omega^R \text{ is reverse of } \omega \}$
and show the moves made by PDA for the string "aabcbaa" and "abacbba". **(10 Marks)**

b. Define Leftmost derivation, Rightmost derivation and Parse tree. Consider the grammar.
$S \to AbB \qquad A \to aA \mid \in$
$B \to aB \mid bB \mid \in \qquad D \to a \mid \in$
Obtain LMD, RMD and parse tree for the string "aaabab". **(10 Marks)**

OR

6 a. Define CFG and design a CFG for the following language.
(i) $L = \{0^m 1^m 2^n \mid m \ge 1 \text{ and } n \ge 0\}$
(ii) $L = \{ \omega\omega^R \mid \omega \in (a, b)^* \}$
(iii) $L = \{a^n b^m c^k \mid n+2m = k \text{ for } m \ge 0 \text{ and } n \ge 0 \}$ **(10 Marks)**

b. Define CNF. Convert the following CFG into CNF.
$S \to ASB \mid \in \qquad A \to aAS \mid a \qquad B \to SbS \mid A \mid bb$ **(10 Marks)**

Module-4

7 a. Define TM and design a turing machine for $L = \{\omega \mid \omega \in (0+1)^*$ containing the substring 001$\}$ Write transition diagram and show the moves made by the Turing machine for input string 10010. **(14 Marks)**

b. Define and explain DTM and NDTM. **(06 Marks)**

OR

8 a. With a neat diagram explain the working of Multitape Turing Machine. **(08 Marks)**

b. Design a Turing machine to accept $L = \{0^n 1^n \mid n \ge 1 \}$. Show the moves made for the string 0011 and 00111. **(12 Marks)**

Module-5

9 Write short notes on :
a. Linear Bound Automata **(06 Marks)**
b. Church Turing Thesis **(07 Marks)**
c. Non-Deterministic Turing Machine **(07 Marks)**

OR

10 a. Explain Halting Problem and Post Correspondence problem in Turing Machine. **(10 Marks)**

b. Discuss the following :
i) Decidable and Undecidable Language **(05 Marks)**
ii) Quantum Computers **(05 Marks)**

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