

A J Institute of Engineering & Technology

Mangalore - 575006



Course File

**AUTOMATA THEORY AND
COMPUTABILITY**
Course Code: 18CS54

Prepared by:

Mrs. Vidya Myageri

Principal
A.J. Institute of Engineering & Technology
Mangaluru - 575 006

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Academic Year

2022 - 2023

FACULTY:	Mrs.Vidya Myageri
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Principal

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



COURSE FILE

AUTOMATA THEORY AND COMPUTABILITY

Course Code: 18CS54

Prepared by
Mrs. Vidya Myageri
Asst. Professor
Dept. of CSE

Approved by
Dr. Antony P J
HOD
Dept. of CSE

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LIST OF FACULTY HANDLED THE COURSE

Sl. No.	ACADEMIC YEAR	FACULTY NAME
1.	2022 - 2023	Mrs. Vidya Myageri


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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

INDEX

ACADEMIC YEAR: 2022- 23 (ODD SEMESTER)

Sl. No.	Particulars
1.	Course Information Sheet
2.	Justification for Complexity Level
3.	Course Delivery Plan
4.	Justification for CO – PO, PSO Mapping
5.	Time Table
6.	Assignment Questions and Solutions
7.	Internal Assessment: Question Paper, Assessment and Scheme & Solution
8.	Question Bank
9.	Attendance Register
10.	Course Delivery Details
11.	Gap in the Syllabus
12.	Content Beyond Syllabus
13.	Notes and Tutorial Problems and Solutions
14.	Text Book (Softcopy)
15.	VTU Question Papers
16.	List of Slow Learners & Impact Analysis
17.	Innovative tools/methods used in Teaching & Learning
18.	Result Analysis
19.	CO-PO, PSO Attainment (Supporting Documents)

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COURSE INFORMATION SHEET

Programme:	Computer Science and Engineering
Degree:	BE
Course:	Automata Theory and Computability
Course Code:	18CS54
Semester:	V
Course Type:	Core
Regulation:	VTU 2018 CBCS Scheme
Credits:	04
Lecture Hours / Week:	03
Total Number of Lecture Hours:	40
Corresponding Lab Course(If any):	-
Corresponding Lab Course Code:	-
Course Area/Domain:	Theoretical Computer Science
PO Mapped:	PO1, PO5
PSO Mapped:	PSO1, PSO2


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COURSE CONTENT:

Module	Details	RBT Level	CO Mapped
1	Why study the Theory of Computation, Languages and Strings: Strings, Languages. A Language Hierarchy, Computation, Finite State Machines (FSM): Deterministic FSM, Regular languages, Designing FSM, Nondeterministic FSMs, From FSMs to Operational Systems, Simulators for FSMs, Minimizing FSMs, Canonical form of Regular languages, Finite State Transducers, Bidirectional Transducers. Textbook 1: Ch 1,2, 3,4, 5.1 to 5.10	L1, L2, L3	CO1
2	Regular Expressions (RE): what is a RE?, Kleene's theorem, Applications of REs, Manipulating and Simplifying REs. Regular Grammars: Definition, Regular Grammars and Regular languages. Regular Languages (RL) and Non-regular Languages: How many RLs, To show that a language is regular, Closure properties of RLs, to show some languages are not RLs. Textbook 1: Ch 6, 7, 8: 6.1 to 6.4, 7.1, 7.2, 8.1 to 8.4	L1, L2, L3	CO2
3	Context-Free Grammars(CFG): Introduction to Rewrite Systems and Grammars, CFGs and languages, designing CFGs, simplifying CFGs, proving that a Grammar is correct, Derivation and Parse trees, Ambiguity, Normal Forms. Pushdown Automata (PDA): Definition of non-deterministic PDA, Deterministic and Non-deterministic PDAs, Nondeterminism and Halting, alternative equivalent definitions of a PDA, alternatives that are not equivalent to PDA. Textbook 1: Ch 11, 12: 11.1 to 11.8, 12.1, 12.2, 12.4, 12.5, 12.6	L1, L2, L3	CO3
4	Algorithms and Decision Procedures for CFLs: Decidable questions, Un-decidable questions. Turing Machine: Turing machine model, Representation, Language acceptability by TM, design of TM, Techniques for TM construction. Variants of Turing Machines (TM), The model of Linear Bounded automata. Textbook 1: Ch 14: 14.1, 14.2, Textbook 2: Ch 9.1 to 9.8	L1, L2, L3	CO4
5	Decidability: Definition of an algorithm, decidability, decidable languages, Undecidable languages, halting problem of TM, Post correspondence problem. Complexity: Growth rate of functions, the classes of P and NP, Quantum Computation: quantum computers, ChurchTuring thesis. Applications: G.1 Defining syntax of programming language, Appendix J: Security	L1, L2, L3	CO5

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Textbook 2: 10.1 to 10.7, 12.1, 12.2, 12.8, 12.8.1, 12.8.2		
Textbook 1: Appendix: G.1(only), J.1 & J.2		

TEXT BOOKS & REFERENCE BOOKS:

T/R	BOOK TITLE / AUTHORS / PUBLICATION
T1	Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson education,2012/2013
T2	K L P Mishra, N Chandrasekaran , 3rd Edition, Theory of Computer Science, PHI, 2012.
R1	John E Hopcroft, Rajeev Motwani, Jeffery D Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson Education, 2013
R2	Michael Sipser : Introduction to the Theory of Computation, 3rd edition, Cengage learning,2013

T- Text Book. R-Reference Book

WEB REFERENCES:

W	WEB ADDRESS
W1	https://www.studocu.com/in/document/sir-mokshagundam-visvesvaraya-institute-of-technology/automata-theory-of-computation/atc/11671263
W2	https://www.slideshare.net/appasami/cs6503-theory-of-computation-book-notes
W3	https://nptel.ac.in/courses/106104028

W- Website

COURSE DESCRIPTION:

The Automata theory and Computability generally known as Theory of Computer Science and Theory of Computation. This course introduces the student to understand the different types language classes and design methods for developing any models. This course also presents concepts of problem solving technique through various techniques and also helps in designing some compiler, any network and security protocols.


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COURSE PREREQUISITES:

COURSE NAME	COURSE CODE	DESCRIPTION	Module
Digital Electronics	18CS33	flip-flops and synchronous sequential state machines	4,5
Discrete Mathematical structure	18CS36	Relations and functions, Graphs and Trees	4,5

COURSE OBJECTIVES: This course will enable students to:

Sl. No.	DESCRIPTION
1	Introduce core concepts in Automata and Theory of Computation
2	Identify different Formal language Classes and their Relationships
3	Design Grammars and Recognizers for different formal languages
4	Prove or disprove theorems in automata theory using their properties
5	Determine the decidability and intractability of Computational problems

COURSE OUTCOMES (COs): After studying this course, students will be able to:

COs	COURSE OUTCOMES	PO MAPPING	PSO MAPPING
CO1	Apply the skills of Theory of computation to design & simulate Finite State machine for a given regular languages	PO1	PSO1
CO2	Apply the properties of Regular Languages to design regular expressions and regular grammar.	PO1	PSO1, PSO2
CO3	Utilize the skill of CFG to Design and Construct CFG and PDA for Context free Languages.	PO1	PSO1
CO4	Acquire the skill on types formal model of decidable problems to design and develop a computing model for context sensitive and semi-decidable languages	PO1	PSO1, PSO2

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CO5	Acquire the skills of computing machine to classify a problem with respect to different models of computation	PO1	PSO1
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COURSE ARTICULATION MATRIX:

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	-	-	1	4	-	-	-	-	-	-	-	2	1
CO4	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	-	-	-	4	-	-	-	-	-	-	-	2	1.5

Course Outcome addresses program outcome: 1 - Lightly, 2 - Moderately, 3 - Highly

GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

Sl. No	Gap	Action taken	Date-Month-Year	Resource Person with designation	No. of students present	Relevance to POs, PSOs
1	-	-	-	-	-	-

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS / ASSIGNMENT / INDUSTRY VISIT / GUEST LECTURER / NPTEL ETC

TOPICS BEYOND SYLLABUS / ADVANCED TOPICS / DESIGN:

Sl. No.	Topics	CO	PO	PSO	METHODOLOGY
1	-	-	-	-	-
2	-	-	-	-	-

Method may be: Theory subjects, Quizzes, Mini Project Work, Lab practices, Seminars assignments, Participation in various conferences, Industrial Visits, workshops and technical Talk.



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DELIVERY / INSTRUCTIONAL METHODOLOGIES:

<input checked="" type="checkbox"/> CHALK & TALK	<input checked="" type="checkbox"/> ASSIGNMENTS	<input checked="" type="checkbox"/> WEB RESOURCES
<input type="checkbox"/> LCD / SMART BOARDS	<input type="checkbox"/> SEMINARS	<input type="checkbox"/> OTHERS

ASSESSMENT METHODOLOGIES – DIRECT:

CONTINUOUS INTERNAL EVALUATION (CIE)

SEMESTER END EXAMINATION (SEE)

ASSESSMENT METHODOLOGIES – INDIRECT:

COURSE EXIT FEEDBACK

OVERALL CO ATTAINMENT LEVEL:

ASSESSMENT TOOL	CO1	CO2	CO3	CO4	CO5
Direct Attainment Level	3	3	3	3	3
Indirect Attainment Level	3	3	3	3	3
Overall Attainment Level	3	3	3	3	3
Average CO Attainment Level					3

Direct Attainment Level = (40% of CIE + 60% of SEE)

Overall Attainment Level = (80% of Direct Attainment Level + 20% of In-Direct Level)

PO- PSO ATTAINMENT THROUGH COs (OVERALL ATTAINMENT METHOD):

PO- PSO Attainment Through CO's (OVERALL Attainment Method)															
Course Index	Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C304	18CS54	2				1								2	1.5

COURSE RESULTS:

NO. OF STUDENTS			S	A	B	C	D	E	F	PASS %	PI
ATTENDED	PASSED	ABSENT									
58	54	00	2	3	12	18	16	3	4	93.10	65.58
No. of FCD (S+A+B) =			17								
No. of FC (C) =			18								
No. of SC (D + E) =			19								

$PI = (S*10 + A*9 + B*8 + C*7 + D*6 + E*4 + F*1) / (10 * \text{total number of students attended})$

Course Instructor

Avidya Mysore

Domain Co-Ordinator

Principal

A.J. Institute of Engineering & Technology

Mangaluru - 575 006

Head of Department

H.O.D. - Computer Science & Engineering
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Justification for CO – PO, PSO Mapping

Course Title: Automata Theory and Computability

Semester: V

Scheme: 18 Scheme

Academic Year: 2022 -2023

Course Code: 18CS54

Hours/Week: 3:2:0

Total Lecture Hours: 40

Course Outcome	PO/PSO MAPPED	Correlation	Justification
CO1 Apply the skill of Theory of computation to design & simulate Finite State Machine for a given regular languages	PO1	2	CO1 is mapped to PO1(Engineering knowledge) This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to design and simulate computation models (Finite State Machines) for solving computational problems. For further assessment analysis tests, the application of mathematics and engineering principles are required to solve problems as per PO1. Hence, the correlation between CO-PO is strong.
	PSO1	2	CO1 is mapped to PSO1(Fundamental Knowledge) - This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to design and simulate computation models (Finite State Machines) for solving computational problems. Hence the correlation between CO - PSO is moderate.

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CO2	Apply the properties of Regular Languages to design regular expressions and regular grammar.	PO1	2	CO2 is mapped to PO1(Engineering knowledge) - This course outcome reflects the measurement of knowledge of science and mathematics (Discrete Mathematics) and engineering fundamentals to design computation models (Regular Expressions and Regular Grammar) for solving computational problems. Further assessment and analysis tests require the application of mathematics and engineering principles to solve problems as per PO1. Hence, the correlation between CO-PO is strong
		PSO1	2	CO2 is mapped to PSO1(Fundamental Knowledge) - This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to design and simulate computation models (Finite State Machines) for solving computational problems. Hence the correlation between CO - PSO is moderate
		PSO2	2	CO2 is mapped to PSO2(Engineering Applications) - This course outcome reflects the measurement engineering skills to design computation models (Regular expressions) for solving computational problems. Hence the


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				correlation between CO - PSO is moderate
CO3	Utilize skill of CFG to Design and Construct CFG and PDA for Context Free Languages	PO1	2	CO3 is mapped to PO1(Engineering knowledge) - This course outcome reflects the measurement of knowledge of science and mathematics (Discrete Mathematics) and engineering fundamentals to design computation models (Context Free Grammar and Push-Down Automata) for solving computational problems. Further assessment and analysis tests require the application of mathematics and engineering principles to solve problems as per PO1. Hence, the correlation between CO-PO is strong
		PO5	1	CO3 is also mapped to PO5(Modern tool usage) - This course outcome reflects the measurement of knowledge of mathematics and logics (Discrete Mathematics), and engineering tools (Lex and Yaac) to understand computation models (Compiler Phases) for solving specific needs. Hence, the correlation between CO-PO is low
		PSO1	2	CO3 is mapped to PSO1(Fundamental Knowledge) - This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to design and simulate computation models

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				(Context Free Grammar and Push-Down Automata) for solving computational problems. Hence the correlation between CO - PSO is moderate.
		PSO2	1	CO3 is mapped to PSO2(Engineering Applications) - This course outcome reflects the measurement engineering skills to design computation models (part of compilers) for solving computational problems. Hence the correlation between CO - PSO is low.
CO4	Acquire the skill on types formal model of decidable problems to design and develop a computing model for Context Sensitive and Semi-Decidable Language	PO1	2	CO4 is mapped to PO1(Engineering knowledge) - This course outcome reflects the measurement of knowledge of science and mathematics (Discrete Mathematics) and engineering fundamentals to design computation models (Turing Machines) for solving computational problems. Further assessment and analysis tests require the application of mathematics and engineering principles to solve problems as per PO1. Hence, the correlation between CO-PO is strong
		PSO1	2	CO4 is mapped to PSO1(Fundamental Knowledge) - This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to design and simulate computation models (Turing Machine) for solving

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				computational problems. Hence the correlation between CO - PSO is moderate
CO5	Apply techniques for controlling the consequences of concurrent data access and database recovery.	PO1	2	CO5 is mapped to PO1 (Engineering knowledge) moderately as the CO reflects the measurement of knowledge of mathematics and engineering principles to solve Post Correspondence Problems and decide whether a problem is solvable or not.
		PSO1	2	CO5 is mapped to PSO1 (Fundamental Knowledge) - This course outcome reflects the measurement of fundamental science and mathematics (Discrete Mathematics) and engineering skills to classify the computation models (Decidable and Undecidable Problems) for solving computational problems. Hence the correlation between CO - PSO is moderate

Correlation: 3 HIGH, 2 MODERATE, 1 LOW

Course Instructor

Domain Co-Ordinator

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COURSE DELIVERY PLAN

Course Title: Automata Theory And Computability

Course Code: 18CS54

Semester: V

Hours/Week: 4

Scheme: 18 Scheme

Academic year: 2021 -2022

Total Lecture Hours: 40

Hours	Topics	Mode	Reference
MODULE – 1			
1	Strings and languages	Chalk & Talk	T1
2	Language Hierarchy	Chalk & Talk	
3	Computation, Finite state machine	Chalk & Talk	
4	Deterministic Finite state machine, regular Languages, Designing DFSM	Chalk & Talk	
5	Deterministic Finite state machine, regular Languages, Designing DFSM	Chalk & Talk	
6	Non-Deterministic Finite machine, RL's, Designing DFSM.	Chalk & Talk	
7	Minimizing FSMs	Chalk & Talk	
8	Canonical form of RL, Finite state transducers, Bidirectional Transducers.	Chalk & Talk	
MODULE – 2			
1	What is RE? Kleene's theorem	Chalk & Talk	T1
2	Applications of REs, Manipulating and simplifying REs	Chalk & Talk	
3	Regular grammars: Definition, Regular grammars and Regular languages.	Chalk & Talk	
4	Regular grammars: Definition, Regular grammars and Regular languages.	Chalk & Talk	
5	Regular Languages (RL) and Nonregular Languages: how many RL's, To show that a language is regular.	Chalk & Talk	
6	Regular Languages (RL) and Nonregular Languages: how many RL's, To show that a language is regular.	Chalk & Talk	
7	Closure properties of Regular Languages.	Chalk & Talk	
8	show that some languages are not RL's	Chalk & Talk	
MODULE – 3			
1	Context Free Grammar (CFG): Introduction to rewrite Systems and Grammars, CFG's and languages.	Chalk & Talk	T1 & T2
2	Designing CFGs	Chalk & Talk	
3	Designing CFGs	Chalk & Talk	
4	Designing CFGs	Chalk & Talk	



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5	Simplifying CFGs, proving that a Grammar is correct, Derivation and Parse trees	Chalk & Talk	
6	Ambiguity	Chalk & Talk	
7	Normal Forms, Pushdown Automata(PDA): Definition of non-deterministic PDA, Deterministic and Non-Deterministic PDA's	Chalk & Talk	
8	Non-Deterministic and halting, alternative equivalent definitions of PDA, alternative that are not equivalent to PDA.	Chalk & Talk	
MODULE - 4			
1	Context Free and Non-context free languages: where do the CFL fits.	Chalk & Talk	T1
2	showing a language is context-free, pumping theorem for CFL	Chalk & Talk	
3	Algorithms and decision procedures for CFLs: Decidable questions, Undecidable questions.	Chalk & Talk	
4	Turing Machines: Turing Machine model, Representation, languages acceptability by TM.	Chalk & Talk	
5	Types of Techniques for TM constructions and variants of TM	Chalk & Talk	
6	Design of TM, Techniques of TM construction	Chalk & Talk	
7	Design of TM, Techniques of TM construction	Chalk & Talk	
8	Design of TM, Techniques of TM construction	Chalk & Talk	
MODULE - 5			
1	Variants of TM , the model of Linear Bounded automata	Chalk & Talk	T2
2	Decidability: definition of an algorithm, decidability	Chalk & Talk	
3	Decidable languages: Undecidable languages	Chalk & Talk	
4	halting problem of TM, post correspondence problem.	Chalk & Talk	
5	Complexity: Growth rate of functions	Chalk & Talk	
6	The classes of P and NP	Chalk & Talk	
7	Quantum computation: quantum computers, quantum computers	Chalk & Talk	
8	Church-Turing thesis	Chalk & Talk	

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TEXT, REFERENCE & ADDITIONAL REFERENCE BOOKS:

	BOOK TITLE / AUTHORS / PUBLICATION
T-1.	Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson education, 2012/2013
T-2.	K L P Mishra, N Chandrasekaran, 3rd Edition, Theory of Computer Science, PHI, 2012.

T- TextBook.

WEB REFERENCE:

	WEB ADDRESS
W1.	https://www.studocu.com/in/document/sir-mokshagundam-visvesvaraya-institute-of-technology/automata-theory-of-computation/atc/11671263
W2.	https://www.slideshare.net/appasami/cs6503-theory-of-computation-book-notes

W- Website

Course Instructor

Domain Co-Ordinator

Head of Department

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Time Table

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability
Semester: V
Scheme: 18 Scheme

Course Code: 18CS54
Hours/Week: 4
Total Lecture Hours: 40

Time Day	9.00 AM TO 9.55 AM	9.55 AM TO 10.50 AM	11.10 AM TO 12:05 AM	12.05 PM TO 1 PM	L U N C H B R E A K	2.00 PM TO 2:55 PM	3:05 PM TO 4:00 PM	4:00 PM TO 4:55 PM
MONDAY				ATC				
TUESDAY				ATC				
WEDNESDAY						ATC		
THURSDAY		ATC						
FRIDAY								
SATURDAY								

Time-Table Co-Ordinator

Head of Department

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NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSIGNMENT-1

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability

Semester: V

Marks: 10

Course Code: 18CS54

Scheme: 18 Scheme

Date of Submission: 28/11/22

Answer the following questions:		Marks	CO																		
1	Design DFA for the following languages: a) strings starting with 'ab' over input alphabets $\Sigma = \{a, b\}$ b) set of all strings starting with 'aa' or 'bb' over input alphabets $\Sigma = \{a, b\}$ c) set of all strings with three consecutive 0's over input alphabets $\Sigma = \{0, 1\}$ d) strings with an even number of 0's followed by single 1 input alphabets $\Sigma = \{0, 1\}$.	04	CO1																		
2.	Minimize the following DFA. <table border="1" style="margin: 10px auto;"> <thead> <tr> <th></th> <th>a</th> <th>b</th> </tr> </thead> <tbody> <tr> <th>$\rightarrow q_0$</th> <td>q1</td> <td>q2</td> </tr> <tr> <th>q1</th> <td>q1</td> <td>q3</td> </tr> <tr> <th>q2</th> <td>q1</td> <td>q2</td> </tr> <tr> <th>q3</th> <td>q1</td> <td>*q4</td> </tr> <tr> <th>*q4</th> <td>q1</td> <td>q2</td> </tr> </tbody> </table>		a	b	$\rightarrow q_0$	q1	q2	q1	q1	q3	q2	q1	q2	q3	q1	*q4	*q4	q1	q2	02	CO1
	a	b																			
$\rightarrow q_0$	q1	q2																			
q1	q1	q3																			
q2	q1	q2																			
q3	q1	*q4																			
*q4	q1	q2																			
3.	Consider the following NFA with ϵ -moves, construct an equivalent DFA. 	02	CO1																		

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4.	Consider the following NFA and construct an equivalent DFA <div style="text-align: center; margin: 10px 0;"> <pre> graph LR q0((q0)) -- "a,b" --> q1((q1)) q1 -- "a" --> q2(((q2))) q3(((q3))) -- "a,b" --> q2 q2 -- "b" --> q3 style q0 stroke-width:2px style q2 stroke-width:4px style q3 stroke-width:4px </pre> </div>	02	CO1
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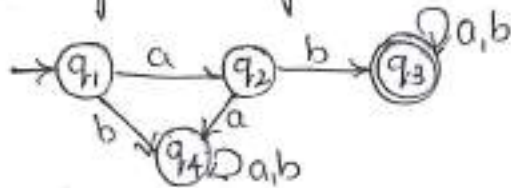
ASSIGNMENT-1 SOLUTION

Academic Year: 2022 -2023 (ODD SEM)

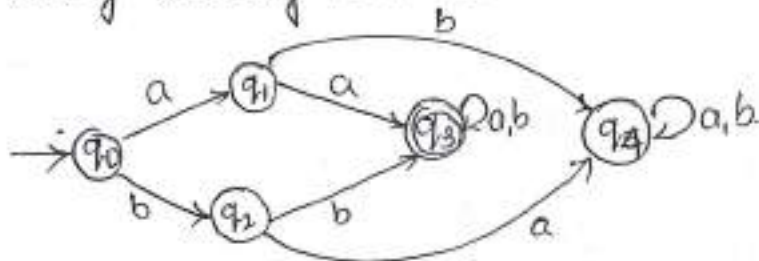
Course Title: Automata Theory and Computability
Semester: V

Course Code: 18CS54
Scheme: 18 Scheme

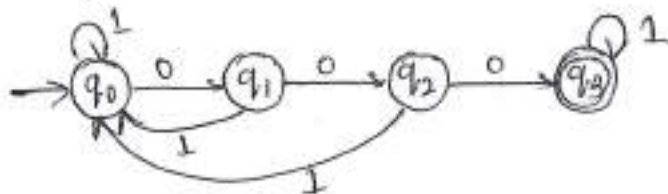
1. a) string starting with ab over alphabet $\Sigma = \{a, b\}$ 4x1 = 4M



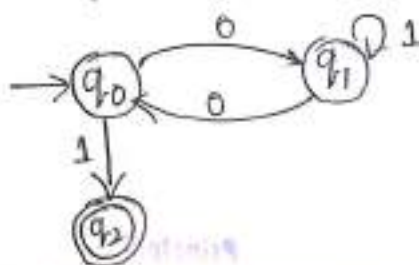
- b) string starting with 'aa' or 'bb' over input alphabet $\Sigma = \{a, b\}$



- c) string with 3 consecutive 0's over input alphabet $\Sigma = \{0, 1\}$



- d) string with an even number of 0's followed by single 1.



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2. Minimise the following DFA.

2M.

δ	a	b
q_0	q_1	q_2
q_1	q_1	q_3
q_2	q_1	q_2
q_3	q_1	$*q_4$
$*q_4$	q_1	q_2

$$E_1 = \{q_0, q_1, q_2, q_3\} \quad E_2 = \{q_4\}$$

$$\delta(q_0, a) = q_1 \quad \delta(q_0, b) = q_2 \quad \therefore q_0 \equiv q_1$$

$$\delta(q_1, a) = q_1 \quad \delta(q_1, b) = q_3$$

$$\delta(q_0, a) = q_1 \quad \delta(q_0, b) = q_2 \quad \therefore q_0 \equiv q_2$$

$$\delta(q_2, a) = q_1 \quad \delta(q_2, b) = q_2$$

$$\delta(q_0, a) = q_1 \quad \delta(q_0, b) = q_2 \quad \therefore q_0 \not\equiv q_3$$

$$\delta(q_3, a) = q_1 \quad \delta(q_3, b) = q_4$$

$$\{q_0, q_1, q_2\} \quad \{q_3\} \quad \{q_4\}$$

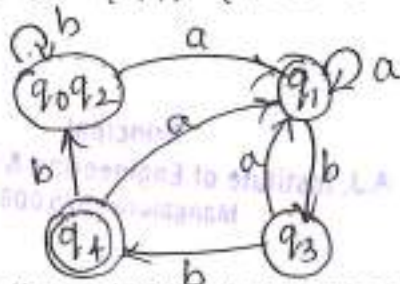
$$\delta(q_0, a) = q_1 \quad \delta(q_0, b) = q_2 \quad \therefore q_0 \not\equiv q_1$$

$$\delta(q_1, a) = q_1 \quad \delta(q_1, b) = q_3$$

$$\delta(q_0, a) = q_1 \quad \delta(q_0, b) = q_2 \quad \therefore q_0 \equiv q_2$$

$$\delta(q_2, a) = q_1 \quad \delta(q_2, b) = q_2$$

$$\{q_0, q_2\} \quad \{q_1\} \quad \{q_3\} \quad \{q_4\}$$



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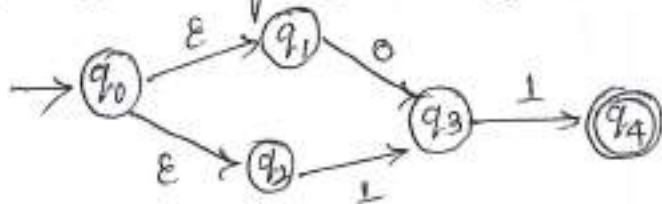
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5. Converting E-NFA to DFA

24



$$E-CLOSE(q_0) = \{q_0, q_1, q_2\}$$

$$E-CLOSE(q_1) = \{q_1\}$$

$$E-CLOSE(q_2) = \{q_2\}$$

$$E-CLOSE(q_3) = \{q_3\}$$

$$E-CLOSE(q_4) = \{q_4\}$$

δ	0	1	ϵ
q_0	ϕ	ϕ	$\{q_0, q_1, q_2\}$
q_1	q_3	ϕ	$\{q_1\}$
q_2	ϕ	q_3	$\{q_2\}$
q_3	ϕ	q_4	$\{q_3\}$
q_4	ϕ	ϕ	$\{q_4\}$

$$\begin{aligned} \delta_D(\{q_0, q_1, q_2\}, 0) &= E-CLOSE(\{q_0, 0\} \cup \{q_1, 0\} \cup \{q_2, 0\}) \\ &= E-CLOSE(\phi \cup q_3 \cup \phi) \\ &= E-CLOSE(q_3) = \{q_3\} \end{aligned}$$

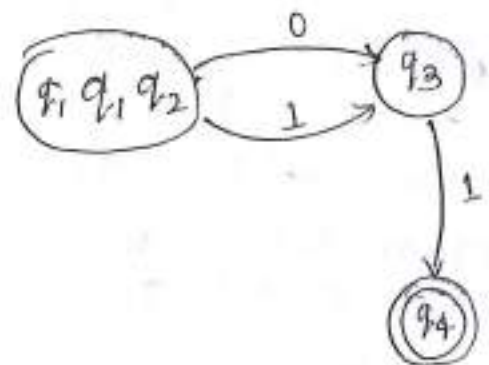
$$\begin{aligned} \delta_D(\{q_0, q_1, q_2\}, 1) &= E-CLOSE(\{q_0, 1\}, \{q_1, 1\}, \{q_2, 1\}) \\ &= E-CLOSE(\phi \cup \phi \cup q_3) \\ &= E-CLOSE(q_3) = \{q_3\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_3, q_1\}) &= E-CLOSE(q_3, 1) \\ &= E-CLOSE(q_4) = \{q_4\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_3, 0\}) &= E-CLOSE(q_3, 0) \\ &= \phi \end{aligned}$$

$$\begin{aligned} \delta_D(q_4, 0) &= E-CLOSE(q_4, 0) \\ &= E-CLOSE(\phi) = \phi \end{aligned}$$

$$\begin{aligned} \delta_D(q_4, 1) &= E-CLOSE(q_4, 1) \\ &= \phi \end{aligned}$$



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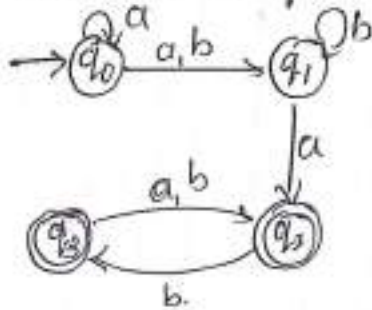
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4. Consider the following NFA & construct an equivalent DFA



δ	a	b
q_0	$q_0 q_1$	q_1
q_1	q_2	q_1
q_2	ϕ	q_3
q_3	q_2	q_2

$$\begin{aligned} \delta_D(\{q_0, q_1\}, a) &= \delta_N(\{q_0, q_1\}, a) \\ &= \delta_N(q_0, a) \cup \delta_N(q_1, a) \\ &= q_0 q_1 \cup q_2 = \{q_0, q_1, q_2\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_0, q_1\}, b) &= \delta_N(\{q_0, q_1\}, b) \\ &= \delta_N(q_0, b) \cup \delta_N(q_1, b) \\ &= q_1 \cup q_1 = \{q_1\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_0, q_1, q_2\}, a) &= \delta_N(\{q_0, q_1, q_2\}, a) \\ &= \delta_N(q_0, a) \cup \delta_N(q_1, a) \cup \delta_N(q_2, a) \\ &= q_0 q_1 \cup q_2 \cup \phi = q_0 q_1 q_2 \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_0, q_1, q_2\}, b) &= \delta_N(\{q_0, q_1, q_2\}, b) \\ &= \delta_N(q_0, b) \cup \delta_N(q_1, b) \cup \delta_N(q_2, b) \\ &= q_1 \cup q_1 \cup q_3 = \{q_1, q_3\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_1, q_3\}, a) &= \delta_N(\{q_1, q_3\}, a) \\ &= \delta_N(q_1, a) \cup \delta_N(q_3, a) \\ &= q_2 \cup q_2 = q_2 \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_1, q_3\}, b) &= \delta_N(\{q_1, q_3\}, b) \\ &= \delta_N(q_1, b) \cup \delta_N(q_3, b) \\ &= q_1 \cup q_2 = \{q_1, q_2\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_1, q_2\}, a) &= \delta_N(\{q_1, q_2\}, a) \\ &= (q_1, a) \cup (q_2, a) \\ &= q_2 \cup \phi = q_2 \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_1, q_2\}, b) &= \delta_N(\{q_1, q_2\}, b) \\ &= q_1 \cup q_3 = \{q_1, q_3\} \end{aligned}$$

$$\begin{aligned} \delta_D(\{q_2\}, a) &= \delta_N(q_2, a) \\ &= \phi \end{aligned}$$

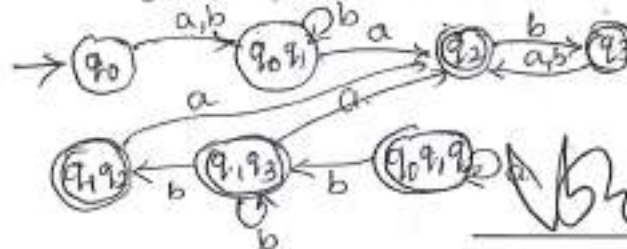
$$\delta_D(q_2, b) = \delta_N(q_2, b) = q_3$$

$$\delta_D(q_3, a) = \delta_N(q_3, a) = q_2$$

$$\delta_D(q_3, b) = \delta_N(q_3, b) = q_2$$

$$\delta_D(q_1, a) = \delta_N(q_1, a) = q_2$$

$$\delta_D(q_1, b) = \delta_N(q_1, b) = q_1$$



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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSIGNMENT-2

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability

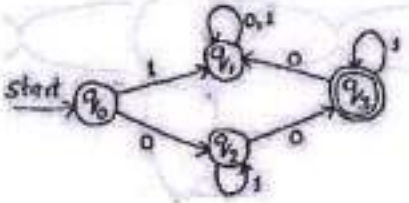
Semester: V

Marks: 10

Course Code: 18CS54

Scheme: 18 Scheme

Date of Submission: 19/12/22

Answer the following questions:		Marks	CO
1	Write the Regular Expression for the following a) $L = \{w \mid w \text{ -starting with a but not having consecutive b's on } \{a,b\}\}$ b) the set of all strings over the alphabet $\{a, b\}$ in which two a's do not come together. c) representing string of a's and b's with alternate a's and b's or no two consecutive letters are same d) Obtain a Regular Expression representing a string of a's and b's such that the ninth symbol from right is 'a' and tenth symbol from right is 'b'.	04	CO2
2.	Prove the given languages are not regular a) $L = \{ww^R \mid w \in \{0+1\}^*\}$ b) $L = \{n_a(w) < n_b(w)\}$	04	CO2
3.	Convert the following automata into regular expression using state elimination technique. 	02	CO2

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSIGNMENT-2 SOLUTION

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability
Semester: V

Course Code: 18CS54
Scheme: 18 Scheme

1 a) $L = \{ w \mid w \text{ - string with } a \text{ but not having consecutive } 1 \times 4 = 4$
b's on } \{a, b\}^*\}

$w = \{ a, ab, aba, abaa, \dots \}$

RE $\Rightarrow a(ba^*)^*$

b) The set of all strings over alphabet $\{a, b\}$ in which ~~no~~ a's
not come together.

$w = \{ a, b, babb, babab, \dots \}$

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

c) Representing strings of a's & b's with alternate a's & b's, or
no consecutive letters are same.

$w = \{ ab, bab, aba, ba, \dots \}$

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

d) strings of a's & b's such that g^{th} symbol from right is 'a'
and t^{th} symbol from right is b.

$(a+b)^*ba(a+b)^*$

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Q. Prove the given languages are not regular. $2 \times 2 = 4$

$$1) L = \{ ww^R \mid w \in (0+1)^* \}$$

step 1: Let L is regular & n be the nos of states in FSM.
considers the string $w = ww^R$.

step 2: since $|w| \geq n$, so we can split w into xyz such that $|xy| \leq n$ & $|y| > 0$.

$$w = \underbrace{1 \dots 10 \dots 00}_{x} \underbrace{00 \dots 01 \dots 1}_{z}$$

step 3: choose a value for i such that xy^iz is not in L .

If $i=0$, the string y does not appear & so nos of 1's on left of w will be less than nos of 1's on the RHS
 \therefore language L is not regular.

$$2) L = \{ w \mid n_a(w) < n_b(w) \} \quad w \in \{a, b\}^*$$

step 1: Let L is regular & n be the nos of states in FSM.
considers the string $w = a^{n-1} b^n \in L$.

step 2: Note that $|w| = 2n-1 \geq n$ & so, we can split w into xyz such that $|xy| \leq n$ & $|y| \geq 1$ as show:

$$w = a^{n-1} b^n = \underbrace{a^{n-1}}_x \underbrace{b^k}_y \underbrace{b^{n-k}}_z$$



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where $|x| = n-1$ & $|y| = k$ & so that $|xy| = |x| + |y| = n-1+k \leq n$.

To satisfy this condition the value of k should be less than or equal to 1.

Step 3 According to pumping lemma $wy^iz \in L$ for $i = 0, 1, 2, \dots$

$$a^{n-1} (b^k)^i b^{n-k} \in L \text{ for } i = 0, 1, 2, \dots$$

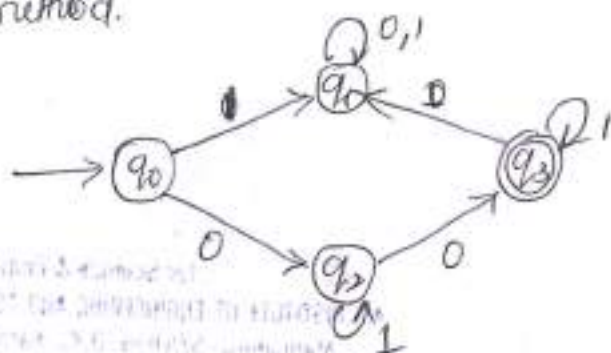
Now if we choose $i = 0$.

$$a^{n-1} b^{n-k} \in L \Rightarrow a^{n-1} b^{n-1} \in L \text{ (when } k=1)$$

So, the nos of a 's & b 's are same, which is contradiction to the assumption that the nos of a 's will be less than nos of b 's.

\therefore The language L is not regular.

3. Convert following automata in RE using state elimination method. 2M.



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Step 1: Remove unreachable state.

In the given FSM, q_1 is unreachable state. after removing state q_1 , the FSM will be:



Step 2: The RE for the FSM is:

$$\Rightarrow 01^*01^*$$

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSIGNMENT-3

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability

Semester: V

Marks: 10

Course Code: 18CS54

Scheme: 18 Scheme

Date of Submission: 7/01/2023

Answer the following questions:		Marks	CO
1	What is context free grammar? Construct CFG for the following languages : i. $L = \{a^n w w^R b^n : w \in \{a,b\}^*\}$ ii. $L = \{xy \mid x \in (a+b)^* y \in (ab \text{ or } ba)\}$. iii. $L = \{a^i b^j c^k : i=j+k, j, k \geq 0\}$ iv. $L = \{0^n 1^n : n \geq 1\}$	03	CO3
2.	For the given Context free grammar. Write left-most derivation, right-most derivation and parse tree. $E \rightarrow I \mid E+E \mid E^*E \mid (E)$ $I \rightarrow a \mid b \mid c \mid d$ string $\Rightarrow (a+b)^* c^* d^*$	03	CO3
3.	For the given grammar find the following: i) Eliminating ungenerated productions ii) Eliminating unreachable productions iii) Eliminating ϵ -production iv) Eliminating Unit productions $S \Rightarrow AB \mid AC$ $A \Rightarrow aAb \mid \epsilon$ $B \Rightarrow bA \mid \epsilon$ $C \Rightarrow bCa$ $D \Rightarrow AB$	04	CO3

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSIGNMENT-3 SOLUTION

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability
Semester: V

Course Code: 18CS54
Scheme: 18 Scheme

1. Context free Grammar :-

1 M

A CFG G is a 4-tuple denoted by $G = (V, \Sigma, R, S)$

where $V \rightarrow$ set of variables or Non terminals

$\Sigma \rightarrow$ set of terminals

$R \rightarrow$ set of productions or rules

$S \rightarrow$ start symbol

construct CFG for the following

$4 \times \frac{1}{2} = 2M$

i) $L = \{ a^n w w^R b^n : w \in \{a, b\}^* \}$

$$L = \{ a^n b^n w w^R : w \in \{a, b\}^* \}$$

$$S \rightarrow AB$$

$$A \rightarrow aAb \mid \epsilon$$

$$B \rightarrow aBb \mid bBa \mid \epsilon$$

ii) $L = \{ xy \mid x \in \{a, b\}^+ \text{ and } y \in \{ba \text{ or } ab\} \}$

$$S \rightarrow AB$$

$$A \rightarrow aAa \mid bAb \mid \epsilon$$

$$B \rightarrow ba \mid ab$$

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iii) $L = \{ a^i b^j c^k : i = j+k, j, k \geq 0 \}$

on substituting $i = j+k$ in L

$$L = \{ a^{j+k} b^j c^k : j, k \geq 0 \}$$

$$L = \{ a^j b^j a^k c^k : j, k \geq 0 \}$$

$$S \rightarrow AB$$

$$A \rightarrow aAb | \epsilon$$

$$B \rightarrow aBc | \epsilon$$

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

$$S \rightarrow 0S1 \mid 01$$

$$A \rightarrow 10A1$$

2. Write LMD, RMD & parse tree for the given grammar 3M.

$$E \rightarrow J \mid E+E \mid E * E \mid (E)$$

$$J \rightarrow a \mid b \mid c \mid d$$

string $\Rightarrow (a+b)^* c^* d^*$

Solⁿ: LMD \Rightarrow

$$\begin{aligned}
 E &\rightarrow \underline{E} * E \\
 &\rightarrow \underline{E} * E * E \\
 &\rightarrow (E) * E * E \\
 &\rightarrow (\underline{E} + E) * E * E \\
 &\rightarrow (1 \underline{E} + \underline{E}) * \underline{E} * E \\
 &\rightarrow (a + \underline{E}) * \underline{E} * \underline{E} \\
 &\rightarrow (a + b) * c * d
 \end{aligned}$$

RMD: $E \rightarrow E * E$

$$\begin{aligned}
 &\rightarrow E * Id \\
 &\rightarrow E * d \\
 &\rightarrow E + \underline{E} * d \\
 &\rightarrow E + J * d \\
 &\rightarrow E * (* d \\
 &\rightarrow (E) * (* d \\
 &\rightarrow (E + E) * (* d \\
 &\rightarrow (E + J) * (* d
 \end{aligned}$$



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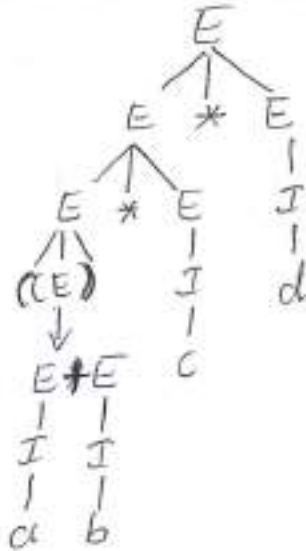
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parse tree :



4M

- 3)
- $S \rightarrow AB/AC$
 - $A \rightarrow aAb/\epsilon$
 - $B \rightarrow bA/\epsilon$
 - $C \rightarrow bCa$
 - $D \rightarrow AB$

i) Eliminate ungenerated productions

→ There are no ungenerated productions of the form $X \rightarrow a$

ii) Eliminating unreachable productions

step 1: check the productions of the form $X \rightarrow \alpha A \beta$, so mark A is reachable

- step 2
- $S \rightarrow AB/AC$
 - $A \rightarrow aAb/\epsilon$
 - $B \rightarrow bA/\epsilon$
 - $C \rightarrow bCa$

iii) Eliminating ϵ -productions

step 1: consider a production of the form $X \rightarrow \epsilon$.

- $A \rightarrow \epsilon$
- $B \rightarrow \epsilon$
- $\therefore \{A, B\}$



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step 2: $\{A, B\}$ is nullable, the CFG now

$$S \rightarrow \epsilon \quad / \quad S \rightarrow AB$$

step 3: The final CFG after removing ϵ -productions

$$S \rightarrow AB|AC|A|B|C$$

$$A \rightarrow aAb|ab$$

$$B \rightarrow bA|b$$

$$C \rightarrow bCa$$

iv) Eliminating unit productions

step 1: list the productions of the $X \rightarrow Y$.

step 2: $S \rightarrow A|B|C$ $S \rightarrow A$ $S \rightarrow B$ $S \rightarrow C$

step 3: start producing productions from the step 2:

$$A \rightarrow aAb|ab$$

$$B \rightarrow bA|b$$

$$C \rightarrow bCa$$

$$S \rightarrow aAb|ab$$

$$S \rightarrow bA|b$$

$$S \rightarrow bCa$$

step 4: The final grammar after eliminating unit productions are:

$$S \rightarrow AB|AC|aAb|ab|bA|b|bCa$$

$$A \rightarrow aAb|ab$$

$$B \rightarrow bA|b$$

$$C \rightarrow bCa$$

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ASSIGNMENT-4

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability

Semester: V

Marks: 10

Course Code: 18CS54

Scheme: 18 Scheme

Date of Submission: 7/01/2023

Answer the following questions:		Marks	CO
1	Define Turing Machines with its tuples. Design a Turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Also give the sequence of ID's for the input 000111 with transition table	04	CO4
2.	Write brief note on the following: a) Multitape TM b) Non-Deterministic TM c) TM with storage head	06	CO4

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ASSIGNMENT-4 SOLUTION

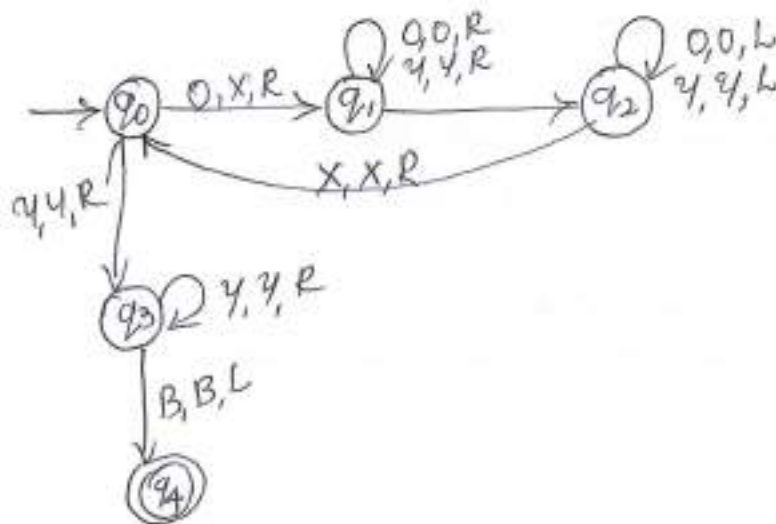
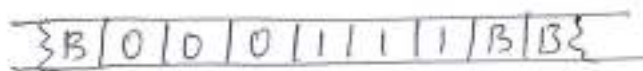
Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability
Semester: V

Course Code: 18CS54
Scheme: 18 Scheme

1. Define Turing Machines with their tuples. Design a Turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Also give the sequence of ID's for the input 000111 with transition table

Q0ⁿ: $L = \{ 01, 0011, 000111, \dots \}$



Transition table

	0	1	X	1	B
→ q ₀	q ₁ X,R	-	-	q ₃ 1,R	-
q ₁	q ₁ 0,R	q ₂ 1,L	-	q ₁ 1,R	-
q ₂	q ₂ 0,L	-	q ₀ X,R	q ₂ 1,L	-
q ₃	-	-	-	q ₃ 1,R	q ₄ B,L
*q ₄	-	-	-	-	-



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Transition TD:

$q_00001111 \vdash q_1001111 \vdash X0q_101111 \vdash X00q_1111 \vdash X0q_20Y11$
 $\vdash Xq_200Y11 \vdash q_2X00Y11 \vdash Xq_000Y11 \vdash XXq_10Y11$
 $\vdash XX0q_1Y11 \vdash XX0Yq_111 \vdash XX0q_2Y41 \vdash XXq_20Y41$
 $\vdash Xq_2X0Y41 \vdash XXq_00Y41 \vdash XXXq_1Y41 \vdash XXXYq_1Y1$
 $\vdash XXXY4q_11 \vdash XXX4Yq_2Y \vdash XXX4q_2Y4 \vdash XXXq_2Y4Y$
 $\vdash XXq_2X4Y4 \vdash XXXq_0Y4Y \vdash XXX4q_3Y4 \vdash XXX4Y4q_3Y$
 $\vdash XXX4Y4q_3Y \vdash XXX4Y4Yq_3B \vdash XXX4Y4Yq_4$ (accepted)

2. write a brief note on

a) Multi-tape Turing Machine

- Multi-tape Turing Machines have many tapes, each with its own head. Each of the heads can move independently of the others.
- Initially, the first tape is consumed as input, and other tapes are kept blank.
- Then the consecutive symbols under its head are read by the machine, the symbols are printed on each tape and its head is moved by the TM.
- The expressive power of a multi-tape Turing computer is similar to that of a k-track Turing machine. Single-tape Turing machines can be used to simulate multi-tape Turing machines.

A multitape TM has :

- a finite set Q of states.
- an initial state q_0 .
- a subset F of Q called the set of final states.
- a set P of tape symbols.
- a new symbol b , not in P called the blank symbol.

assume that $\Sigma \subseteq \Gamma$ and $b \in \Sigma$.)

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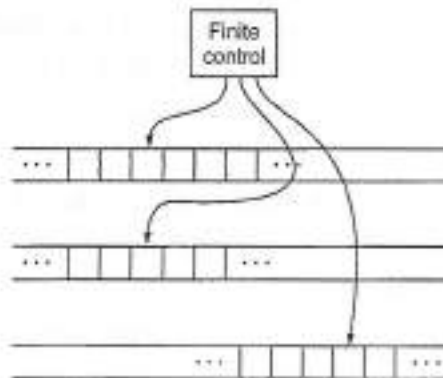
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- There are k tapes, each divided into cells. The first tape holds the input string w . Initially, all the other tapes hold the blank symbol.
- Initially the head of the first tape (input tape) is at the left end of the input w . All the other heads can be placed at any cell initially.
- δ is a partial function from $Q \times \Gamma^k$ into $Q \times \Gamma^k \times \{L, R, S\}^k$.
A move depends on the current state and k tape symbols under k tape heads.
- In a typical move:
 - (i) M enters a new state.
 - (ii) On each tape, a new symbol is written in the cell under the head.
 - (iii) Each tape head moves to the left or right or remains stationary. The heads move independently: some move to the left, some to the right and the remaining heads do not move.
- The initial ID has the initial state q_0 , the input string w in the first tape (input tape), empty strings of b 's in the remaining $k - 1$ tapes. An accepting ID has a final state, some strings in each of the k tapes.

b) Non-Deterministic TM:

Definition 9.5 A nondeterministic Turing machine is a 7-tuple $(Q, \Sigma, \Gamma, \delta, q_0, b, F)$ where

1. Q is a finite nonempty set of states
2. Γ is a finite nonempty set of tape symbols
3. $b \in \Gamma$ is called the blank symbol
4. Σ is a nonempty subset of Γ , called the set of input symbols. We assume that $b \notin \Sigma$.
5. q_0 is the initial state
6. $F \subseteq Q$ is the set of final states
7. δ is a partial function from $Q \times \Gamma$ into the power set of $Q \times \Gamma \times \{L, R\}$.

Theorem: If M is a nondeterministic TM, there is a deterministic TM M_1 such that $T(M) = T(M_1)$

Proof: We construct M_1 as a multitape TM. Each symbol in the input string leads to a change in ID. M_1 should be able to reach all IDs and stop when an ID containing a final

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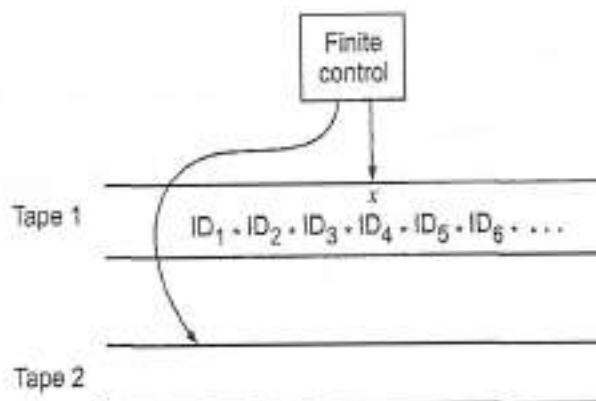
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state is reached. So the first tape is used to store IDs of M as a sequence and also the state of M . These IDs are separated by the symbol $*$ (included as a tape symbol). The current ID is known by marking an x along with the ID-separator $*$ (The symbol $*$ marked with x is a new tape symbol.)

All IDs to the left of the current one have been explored already and so can be ignored subsequently. Note that the current ID is decided by the current input symbol of w . The below illustrates the deterministic TM M_1 .



1. M_1 examines the state and the scanned symbol of the current ID. Using the knowledge of moves of M stored in the finite control of M_1 , it checks whether the state in the current ID is an accepting state of M . In this case M_1 accepts and stops simulating M .

2. If the state q say in the current ID $xqay$, is not an accepting state of M_1 and $\delta(q, a)$ has k triples, M_1 copies the ID $xqay$ in the second tape and makes k copies of this ID at the end of the sequence of IDs in tape 2.
3. M_1 modifies these k IDs in tape 2 according to the k choices given by $\delta(q, a)$.
4. M_1 returns to the marked current ID, erases the mark x and marks the next ID-separator $*$ with x . Then M_1 goes back to step 1.

c) TM with storage head

Suppose, we want to include the option that the head can continue to be in the same cell for some input symbol. Then we define (q, a) as (q', y, S) . This means that the TM, on reading the input symbol a , changes the state to q' ; and writes y in the current cell in place of a and continues to remain in the same cell. In this model $(q, a) = (q', y, D)$ where $D = L, R$ or S .

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ASSIGNMENT-5

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability

Semester: V

Marks: 10

Course Code: 18CS54

Scheme: 18 Scheme

Date of Submission: 20/1/23

Answer the following questions:		Marks	CO
1	Explain the following with example: a) Halting problem of TM b) Post correspondence problem c) Growth rate of functions	06	CO5
2.	Explain Quantum Computations.	04	CO5

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ASSIGNMENT-5 SOLUTION

Academic Year: 2022 -2023 (ODD SEM)

Course Title: Automata Theory and Computability
Semester: V

Course Code: 18CS54
Scheme: 18 Scheme

1. Explain the following with example

a) HALTING PROBLEM OF TM

→ Halting problem may be undecidable problem i.e. it may go infinite loop.

Defⁿ: If M is a TM, we have to identify whether (M, w) halts or does not halt when w is applied as input.

→ Alan Turing in 1936 proved that halting problem is undecidable

Let $HALT = \{ (M, w) : \text{The TM } M \text{ halts on input } w \}$ is undecidable?

proof: Let $HALT$ is decidable & get a contradiction

Let M_1 is TM such that $L(M_1) = HALT$

Let us construct TM M_2 as follows:

1) For TM M_2 (M_1, w) is input.

2) For TM M_1 , acts on (M, w)

3) If TM M_1 rejects (M, w) , then TM M_2 rejects (M, w)

4) If TM M_1 accepts (M, w) means TM M simulates the input string w until M halts.

5) If TM M accepted w , TM M_2 accepts (M, w) otherwise rejects.

We can observe the following points:

1) when M_1 accepts (M, w) , the TM M halts on w

2) In step 5, M_2 accepts (M, w)

3) In step 6, M_2 rejects (M, w)

∴ The TM M halts on given input w is undecidable.

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b) Post Correspondence problem:

Definition: The post correspondence problem can be stated as follows.

Given two sequences of n strings on some alphabet Σ say.

$$A = w_1, w_2, \dots, w_n \quad \& \quad B = v_1, v_2, \dots, v_n$$

We say that there exists a post correspondence solution for pair (A, B) if there is a nonempty sequence of integers i, j, \dots, k such that

$$w_i w_j \dots w_k = v_i v_j \dots v_k$$

The post Correspondence problem is to devise an algorithm that will inform us, for any (A, B) whether or not there exists a PC-solution.

For example, let $\Sigma = \{0, 1\}$ let A is w_1, w_2, w_3 as shown below:

$$w_1 = 11, \quad w_2 = 100, \quad w_3 = 111$$

let B is v_1, v_2, v_3 as shown below:

$$v_1 = 111, \quad v_2 = 001, \quad v_3 = 11$$

let for this case, there exist a PC-solution as below:

$$\begin{array}{ccccccc}
 \overbrace{11}^{w_1} & \overbrace{100}^{w_2} & \overbrace{111}^{w_3} & & & & \\
 11 & 100 & 111 & & & & \\
 \underline{111} & \underline{001} & \underline{11} & & & & \\
 v_1 & v_2 & v_3 & & & &
 \end{array}$$

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c) GROWTH RATE OF FUNCTIONS

→ Given two algorithms to solve the same problem, it is necessary to compare those algorithms to find out which is more efficient.

→ We normally use big O notation which is defined below.

Defn: Let $f(n)$ be the time efficiency of an algorithm. The function $f(n)$ is said to be $O(g(n))$ denoted by

$$f(n) = O(g(n))$$

iff there exists a positive constant c & positive integer n_0 satisfying the condition: $f(n) \leq c * g(n) \quad \forall n \geq n_0$

Theorem: If $f(n) = a_k n^k + a_{k-1} n^{k-1} + a_{k-2} n^{k-2} + \dots + a_1 n^1 + a_0$

Each term in the summation is of the form $a_i n^i$. Since, n is non negative, a particular term will be negative only if $a_i < 0$, so,

$$|f(n)| = |a_k n^k + a_{k-1} n^{k-1} + \dots + a_1 n^1 + a_0|$$

$$\leq |a_k| n^k + |a_{k-1}| n^{k-1} + \dots + |a_1| n^1 + |a_0|$$

$$\leq n^k \left[|a_k| + \frac{|a_{k-1}|}{n} + \dots + \frac{|a_1|}{n^{k-1}} + \frac{|a_0|}{n^k} \right]$$

$$\leq n^k (|a_k| + |a_{k-1}| + \dots + |a_1| + |a_0|)$$

$$\leq c * n^k \text{ where } c = (|a_k| + |a_{k-1}| + \dots + |a_1| + |a_0|)$$

$$f(n) \leq c * n^k$$

$$f(n) \leq c * g(n) \quad \forall n \geq n_0 \text{ where } g(n) = n^k \text{ & } n_0 = 1$$

so, by the definition, we can write

$$f(n) = O(g(n))$$

$$f(n) = O(n^k)$$



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2. Explain Quantum computation

a) QUANTUM COMPUTERS

- The computers that built based on the principles of quantum mechanics are called quantum computers.
- Quantum computers data are represented mathematically as shown: $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$
- Two possible states are $|0\rangle$ & $|1\rangle$. 0 & 1 are called computational basis states. ψ called superposition. Expression is called quantum state.
- we get a state $|0\rangle$ with probability $|\alpha|^2$ & state $|1\rangle$ with probability $|\beta|^2$.
- Multiple qubits can be defined ex: $|00\rangle, |11\rangle$ etc.
- A quantum computer is a system built from number of quantum circuit containing fibres & gates such as NOT, OR, AND etc.

b) CHURCH-TURING THESIS

- Defⁿ: Any effective computation or any algorithmic procedure that can be carried out by a human being or a team of human beings or a computer, can be carried out by some TM.
- There is an effective procedure to solve a decision problem P iff there is a TM that answers yes for input $w \in P$ & no for $w \notin P$.
 - This thesis predicts that it is unable to construct models of computation more powerful than the existing one.
 - Church Turing thesis: We cannot go beyond TM or their equivalent.
 - since majority of scientist have accumulated enough evidence over the years that has caused church thesis to be accepted.

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V SEMESTER B.E. DEGREE

I INTERNAL ASSESSMENT, NOV 2022

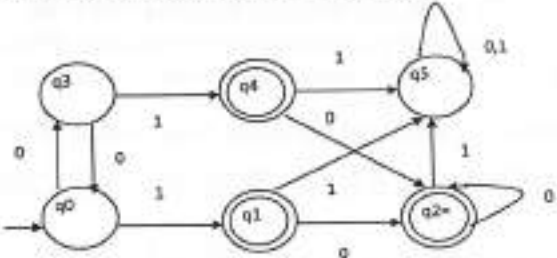
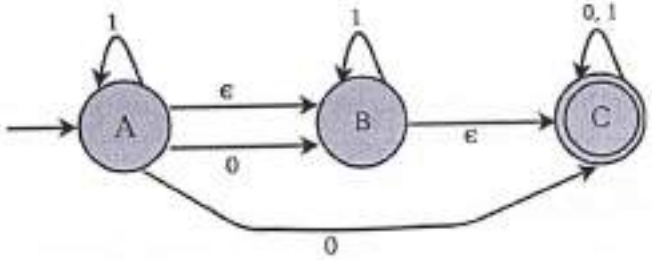
18CS54 – AUTOMATA THEORY AND COMPUTABILITY

Duration: 90 Mins

Max Marks: 50

Note: Answer any three full questions, selecting at least ONE question from each part

PART-A		Marks	CO	RBT
1 a)	Explain the following with examples: i)String ii)Alphabets iii)symbols iv)language v)Kleene Closure	10	CO1	L2
b)	(i)Design a DFSA to accept a string 'a's and 'b's not ending with "abb" (ii)Design a DFSA which accepts an odd number of 0's and an odd number of 1's on $\Sigma = \{0,1\}$.	10	CO1	L3
OR				
2 a)	(i)what are transducers? Explain Finite State transducers with examples. (ii)Difference between DFSA and NFSM?.	10	CO1	L2
b)	(i) With a neat diagram, explain the hierarchy of language classes in automata theory. (ii)Draw DFSA, which accepts a set of all binary strings over $\{0, 1\}$, which is divisible by '3'.	10	CO1	L3
PART- B				
3 a)	Define Non-Deterministic FSM and Design NFSM for Language on $\Sigma = \{a,b\}$ (i) $L = \{w : w \text{ accepts all strings in which the third symbol from the right end is always } a\}$. (ii) $L = \{w : w \text{ is made up of an optional 'a' followed by 'aa' followed by zero or more b's}\}$.	10	CO1	L3
b)	Convert the following NDFSA to its equivalent DFSA and also write a transition table for DFSA	10	CO1	L3
OR				

4 a)	Construct a minimized DFSM for the following: 	10	CO1	L3
b)	consider the following ϵ -NFSM:  <p>i) compute the ϵ-closure of each state ii) convert the automata to DFA.</p>	10	CO1	L3
PART- C				
5	(A) Define Regular expressions. Write the regular expression for the following languages: i) Representing strings of a's and b's having odd length. ii) To accept strings of a's and b's such that the third symbol from the right is 'a' and fourth symbol from the right is 'b'.	10	CO2	L2
OR				
6	(i) Show that regular languages are closed under union and concatenation. (ii) Obtain a RE for the language $L = \{a^n b^m \mid m+n \text{ is even}\}$ (iii) $L = \{a^n b^m \mid m \geq 1, n \geq 1, nm \geq 3 \text{ is even}\}$	10	CO2	L2



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ASSESSMENT: COGNITIVE LEVEL MAPPING

ACADEMIC YEAR: 2022-2023

Course Title	AUTOMATA THEORY AND COMPUTABILITY		
Course Code	18CS54		
Semester	V	IA Test:	I

Q No	Level of questions (RBT)	Marks	(Course Outcome)	Remarks
1.a	L2	10	CO1	
1.b	L3	10	CO1	
2.a	L2	10	CO1	
2.b	L3	10	CO1	
3.a	L3	10	CO1	
3.b	L3	10	CO1	
4.a	L3	10	CO1	
4.b	L3	10	CO1	
5	L2	10	CO2	
6	L2	10	CO2	
	Total:	100		


Vidya Myagere

Name & Signature of Course Instructor:

CO Coverage Details:

CO	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
1	80/100	80	
2	20/100	20	

RBTL Details:

Level (RBT)	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
L2	40/100	40	
L3	60/100	60	


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A Unit of Laxmi Memorial Education Trust

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NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

V Semester B.E. Degree First Internal Assessment, Nov 2022

Scheme and Solution

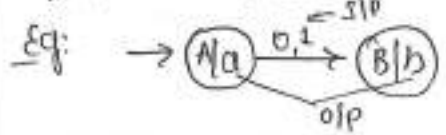
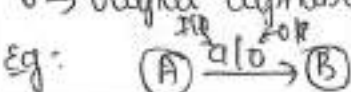
Course Title: AUTOMATA THEORY AND COMPUTABILITY

Course Code: 18CS54

Question No.	Scheme and Solution	Mar
1.a)	<p>i) <u>string</u>: is a sequence of any no. of symbols from Σ. Eg \Rightarrow 0, 1, 11, 00 & 01101 are strings over $\{0, 1\}$ \Rightarrow cat, CAT, computer are strings over $\{a-z\}$</p> <p>ii) <u>alphabet</u>: is a finite, non-empty set of symbols Eg: $\{0, 1\}$ is a binary alphabet.</p> <p>iii) <u>Symbols</u>: Σ is a character, is the smallest building block, which can be any alphabet, letter or picture.</p> <p>iv) <u>Language</u>: finite or infinite set of strings over a finite alphabet. Eg $L = \{a, b\}^* = \{\epsilon, a, b, aa, ab, bb, aab, \dots\}$</p> <p>v) <u>Kleen closure</u>: L^* is the set of strings that can be formed by concatenating together zero or more strings from L. $L^* = \{\epsilon\} \cup \{w \in \Sigma^*\}$</p>	2x5=10
1 b.	<p>i)</p> <pre> graph LR q0((q0)) -- a --> q1((q1)) q1 -- a --> q2((q2)) q2 -- b --> q3(((q3))) q3 -- b --> q0 q1 -- b --> q0 q2 -- a --> q1 </pre> <p>ii)</p> <pre> graph LR q0((q0)) -- 0 --> q1((q1)) q1 -- 0 --> q0 q0 -- 1 --> q2((q2)) q2 -- 1 --> q0 q1 -- 1 --> q3(((q3))) q3 -- 1 --> q1 q2 -- 0 --> q3 q3 -- 0 --> q2 </pre>	2x5=10

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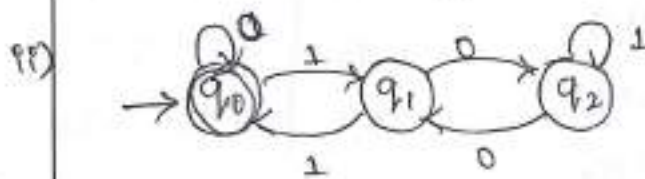
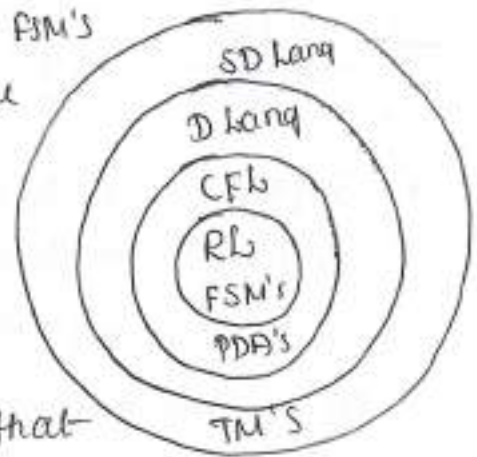
<p>2 a)</p>	<p>1) Transducers: Defined as a device that converts one form of energy to another.</p> <p>Finite state transducers:</p> <p>1. <u>Moore Machine</u>: The output depends on current state & its output value associated to it. $(Q, q_0, \Sigma, O, \delta, D)$ $Q \rightarrow$ set of states $\Sigma \rightarrow$ set of alphabets $\delta \rightarrow Q \times \Sigma$ $q_0 \rightarrow$ initial state $O \rightarrow$ output " $D: Q \rightarrow O$</p> <p>Eg:  Spot light examples</p> <p>2. <u>Mealy Machine</u>: The output depends on current state & input symbol. $(Q, q_0, \Sigma, O, \delta, D)$ $Q \rightarrow$ set of states $q_0 \rightarrow$ initial state, $\Sigma \rightarrow$ set of alphabets, $\delta \rightarrow Q \times \Sigma$ $O \rightarrow$ output alphabets $D: Q \times \Sigma \rightarrow O$</p> <p>Eg:  Eg: Barcode</p>	<p>6 M</p>		
<p>19)</p>	<table border="0"> <tr> <td style="vertical-align: top;"> <p><u>DFSM</u></p> <p>1) For each symbolic representⁿ of the alphabet, there is only one state transition in DFA</p> <p>2. DFA cannot use empty string transition</p> <p>3. DFA can be understood as one machine</p> <p>4. It is difficult to construct</p> <p>5. All DFA are NFA</p> <p>6. $Q \times \Sigma \rightarrow Q$</p> </td> <td style="vertical-align: top;"> <p><u>NDFSM</u></p> <p>1. No need to specify how does the NFA react according to some symbol.</p> <p>2. NFA can use empty string transition</p> <p>3. NFA can understood as multiple mc.</p> <p>4. NFA is easier to construct</p> <p>5. Not all NFA are DFA</p> <p>6. $Q \times \Sigma \rightarrow 2^Q$</p> </td> </tr> </table>	<p><u>DFSM</u></p> <p>1) For each symbolic representⁿ of the alphabet, there is only one state transition in DFA</p> <p>2. DFA cannot use empty string transition</p> <p>3. DFA can be understood as one machine</p> <p>4. It is difficult to construct</p> <p>5. All DFA are NFA</p> <p>6. $Q \times \Sigma \rightarrow Q$</p>	<p><u>NDFSM</u></p> <p>1. No need to specify how does the NFA react according to some symbol.</p> <p>2. NFA can use empty string transition</p> <p>3. NFA can understood as multiple mc.</p> <p>4. NFA is easier to construct</p> <p>5. Not all NFA are DFA</p> <p>6. $Q \times \Sigma \rightarrow 2^Q$</p>	<p>4 M</p>
<p><u>DFSM</u></p> <p>1) For each symbolic representⁿ of the alphabet, there is only one state transition in DFA</p> <p>2. DFA cannot use empty string transition</p> <p>3. DFA can be understood as one machine</p> <p>4. It is difficult to construct</p> <p>5. All DFA are NFA</p> <p>6. $Q \times \Sigma \rightarrow Q$</p>	<p><u>NDFSM</u></p> <p>1. No need to specify how does the NFA react according to some symbol.</p> <p>2. NFA can use empty string transition</p> <p>3. NFA can understood as multiple mc.</p> <p>4. NFA is easier to construct</p> <p>5. Not all NFA are DFA</p> <p>6. $Q \times \Sigma \rightarrow 2^Q$</p>			

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2. b) We have now defined 4 lang:

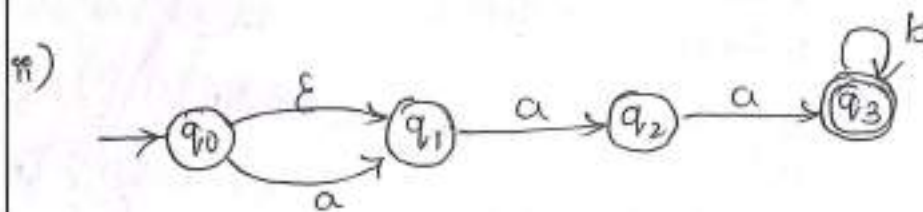
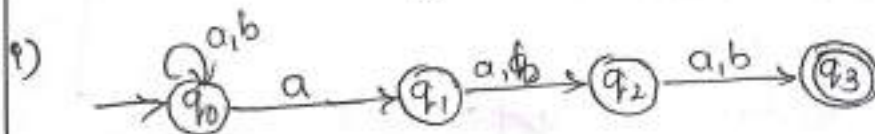
- * RL, which can be accepted by some FSM's
- * CFL, which can be accepted by some PD's
- * Decidable Lang, which can be decided by some Turing m/c that always halts.
- * Semidecidable (SD) Lang, by TM that halts on all strings in the lang.



2x5 = 10M

3 a) NFSM: It consists of 5 tuples $\{Q, \Sigma, q_0, F, \delta\}$

- $Q \rightarrow$ set of all states
- $\Sigma \rightarrow$ set of input symbols
- $q_0 \rightarrow$ Initial state
- $F \rightarrow$ set of final state
- $\delta \rightarrow$ transition function: $\delta: Q \times \Sigma \rightarrow 2^Q$



2M

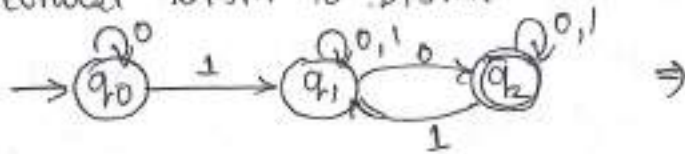
4M

4M

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10M

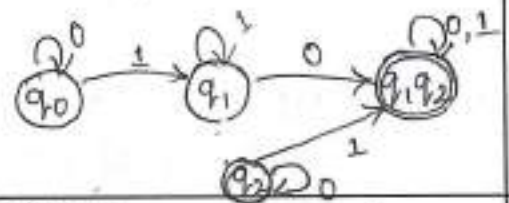
3. b. convert NFSM to DFSM.



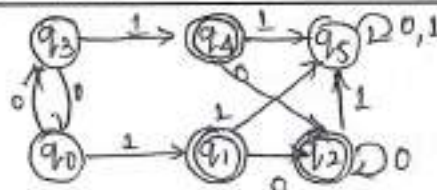
	0	1
q ₀	q ₀	q ₁
q ₁	q ₁ q ₂	q ₁
q ₂	q ₂	q ₂ q ₁

- $\delta_D(q_0, 0) \Rightarrow \delta_N(q_0, 0) = q_0$
 $\delta_D(q_0, 1) \Rightarrow \delta_N(q_0, 1) = q_1$
- $\delta_D(q_1, 0) \Rightarrow \delta_N(q_1, 0) = q_1q_2$
 $\delta_D(q_1, 1) \Rightarrow \delta_N(q_1, 1) = q_1$
- $\delta_D(q_1q_2, 0) \Rightarrow \delta_N(q_1, 0) \cup \delta_N(q_2, 0)$
 $= q_1q_2 \cup q_2 = q_1q_2$
- $\delta_D(q_1q_2, 1) \Rightarrow \delta_N(q_1, 1) \cup \delta_N(q_2, 1)$
 $= q_1 \cup q_2q_1 = q_1q_2$
- $\delta_D(q_2, 0) = \delta_N(q_2, 0) = q_2$
 $\delta_D(q_2, 1) = \delta_N(q_2, 1) = q_1q_2$

	0	1
q ₀	q ₀	q ₁
q ₁	q ₁ q ₂	q ₁
q ₂	q ₂	q ₁ q ₂
q ₁ q ₂	q ₁ q ₂	q ₁ q ₂



4. a) Minimize DFSM.



$G_1 = \{q_0, q_3, q_5\}$ $G_2 = \{q_1, q_2, q_4\}$

consider $\{q_0, q_3, q_5\}$

$q_0 \xrightarrow{0} q_3$ $q_0 \xrightarrow{1} q_1$ $\therefore q_0 \not\equiv q_3$

$q_3 \xrightarrow{0} q_0$ $q_3 \xrightarrow{1} q_4$

$q_0 \xrightarrow{0} q_3$ $q_0 \xrightarrow{1} q_1$ $\therefore q_0 \not\equiv q_5$

$q_5 \xrightarrow{0} q_5$ $q_5 \xrightarrow{1} q_5$

$q_3 \xrightarrow{0} q_0$ $q_3 \xrightarrow{1} q_4$ $\therefore q_3 \not\equiv q_5$

$q_5 \xrightarrow{0} q_5$ $q_5 \xrightarrow{1} q_5$

$\{q_0, q_3, q_5\}$ $\{q_1, q_2, q_4\}$

consider $\{q_1, q_2, q_4\}$

$q_1 \xrightarrow{0} q_2$ $q_1 \xrightarrow{1} q_5$ $\therefore q_1 \equiv q_2$

$q_2 \xrightarrow{0} q_2$ $q_2 \xrightarrow{1} q_5$

$q_1 \xrightarrow{0} q_2$ $q_1 \xrightarrow{1} q_5$ $\therefore q_1 \equiv q_4$

$q_4 \xrightarrow{0} q_2$ $q_4 \xrightarrow{1} q_5$

	0	1
q ₀	q ₃	q ₁
+ q ₁	q ₂	q ₅
+ q ₂	q ₂	q ₅
q ₃	q ₀	q ₄
+ q ₄	q ₂	q ₅
q ₅	q ₅	q ₅

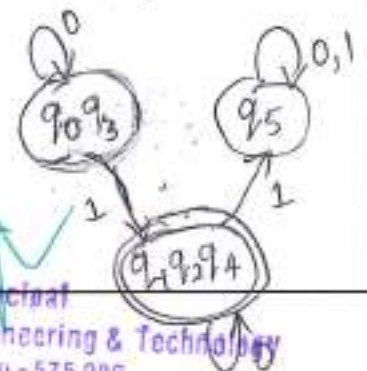
Now consider $\{q_0, q_3\}$

$q_0 \xrightarrow{0} q_3$ $q_0 \xrightarrow{1} q_1$ $\therefore q_0 \not\equiv q_3$

$q_3 \xrightarrow{0} q_0$ $q_3 \xrightarrow{1} q_4$

$G_1 = \{q_0, q_3, q_5\}$ $G_2 = \{q_1, q_2, q_4\}$

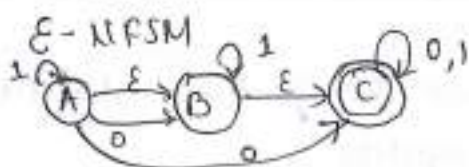
The DFA



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4. b)



	0	1	ε
A	BC	A	ABC
B	φ	B	BC
C	C	C	C

10M

$ECLOSE(A) = \{A, B, C\}$

$ECLOSE(B) = \{BC\}$

$ECLOSE(C) = \{C\}$

1. $\delta_D(\{A, B, C\}, 0) = ECLOSE\{\delta(A, B, C), 0\}$

$= ECLOSE\{BC \cup \phi \cup C\}$

$= ECLOSE\{BC\} = BC$

2. $\delta_D(\{A, B, C\}, 1) = ECLOSE\{\delta(A, B, C), 1\}$

$= ECLOSE\{A \cup B \cup C\} = ABC$

3. $\delta_D(\{B, C\}, 0) = ECLOSE\{\delta(B, C), 0\}$

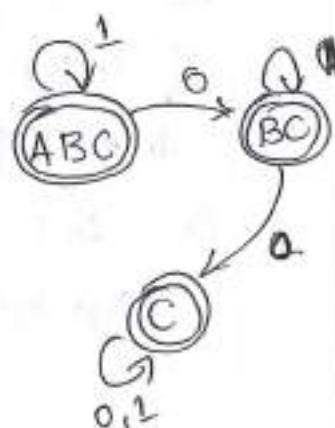
$= ECLOSE\{\phi \cup C\} = C$

4. $\delta_D(\{B, C\}, 1) = ECLOSE\{\delta(B, C), 1\}$

$= ECLOSE\{B, C\} = \{BC\}$

5. $\delta_D(C, 0) = ECLOSE(C) = C$

6. $\delta_D(C, \phi) = ECLOSE(C) = C$



5. a) RE: A lang accepted by FSM can be easily described by 2M.
simple expression called RE. It has mainly 4 tools on which we can write RE

* ϕ is an empty lang.

* ϵ is an empty string

* If R_1, R_2 are RE then $R_1 \cup R_2$ are RE

* If R_1, R_2 " RE then $R_1 \cdot R_2$ are RE.

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

ii) $(a+b)^* ba(a+b)(a+b)$

4M


4M

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6. ii) p)	<p>RE are closed under union:</p> <p>If $L(\beta)$ & $L(\gamma)$ are two lang. their union $L(\beta) \cup L(\gamma)$ will also be regular.</p> <p>ex: $L_1 = \{a^n \mid n \geq 0\}$ $L_2 = \{b^n \mid n \geq 0\}$ $L_3 = L_1 \cup L_2 = \{a^n \cup b^n \mid n \geq 0\}$ also regular</p> <p>RE are closed under concatenation</p> <p>If $L(\beta)$ & $L(\gamma)$ are two lang. their concatenation $L(\beta) \cdot L(\gamma)$ will also be regular.</p> <p>ex $L_1 = \{a^n \mid n \geq 0\}$ $L_2 = \{b^n \mid n \geq 0\}$ $L_3 = L_1 \cdot L_2 = \{a^n b^n \mid n \geq 0\}$ also regular</p>	4M
ii)	<p>$L = \{a^n b^m \mid m+n \text{ is even}\}$</p> <p>case 1: $m+n = \text{even}$ $m \rightarrow \text{even}$ $n \rightarrow \text{even}$ $(aa)^* (bb)^*$</p> <p>case 2: $m+n = \text{even}$ $m \rightarrow \text{odd}$ $n \rightarrow \text{odd}$ $a(aa)^* b(bb)^*$</p> <p>RE: $(aa)^* (bb)^* + a(aa)^* b(bb)^*$</p>	3M
iii)	<p>$L = \{a^n b^m \mid m \geq 1, n \geq 1, nm \geq 3\}$</p> <p>case 1: since $nm \geq 3$, $m=1, n \geq 3 \Rightarrow aaaa^+b$</p> <p>case 2: " " $n \neq 1, m \geq 3 \Rightarrow abbbb^+$</p> <p>case 3: " " $n \geq 2, m \geq 2 \Rightarrow aaaa^+bbb^+$</p> <p>RE $\Rightarrow aaaa^+b + abbbb^+ + aaaa^+bbb^+$</p>	3M



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Domain Co-Ordinator



Head of Department

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

V SEMESTER B.E. DEGREE

II INTERNAL ASSESSMENT, DEC 2022

18CS54 – AUTOMATA THEORY AND COMPUTABILITY

Duration: 90 Mins

Max Marks: 50

Note: Answer any three full questions, selecting at least ONE question from each part

PART-A		Marks	CO	RBT
1 a)	Build Regular Expression for the following FSM: 	10	CO2	L3
b)	Build an FSM that accepts the language defined by this regular expression $(a+b)^*aa(a+b)^*$.	10	CO2	L3
OR				
2 a)	Construct a grammar to accept the following language: (i) $L = \{w \mid n_a(w) \bmod 2 = 0 \text{ where } w \in \{a,b\}^*\}$ (ii) $L = \{w \mid w \bmod 3 > 0, \text{ where } w \in \{a,b\}^*\}$	10	CO2	L3
b)	Construct a FSM from the following grammar: $S \Rightarrow aT$ $T \Rightarrow bT$ $T \Rightarrow a$ $T \Rightarrow aW$ $W \Rightarrow \epsilon$ $W \Rightarrow aT$ and obtain the equivalent RE.	10	CO2	L3
PART- B				
3 a)	i) Define Context Free grammar. Write the grammar for the following languages. a) $L = \{a^i b^j c^k \mid i=j+k, j, k \geq 0\}$ b) $L = \{0^n 1^n \mid n \geq 1\}$	10	CO1	L2
b)	Consider the CFG with production: $E \rightarrow E * T / T$ $T \rightarrow F - T / F$ $F \rightarrow (E) / 0 / 1$ write left-most derivation, right-most derivation and parse tree for the string "0-((1*0)-0)".	10	CO1	L3

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OR					
4 a)	What is Ambiguous grammar? show the following grammar is ambiguous. i) $S \rightarrow AB/bA$ $A \rightarrow aS/bAA/a$ $B \rightarrow bS/aBB/b$	ii) $S \rightarrow iCtS \mid iCtSeS \mid x,$ $C \Rightarrow y$	10	CO1	L2
b)	Consider the grammar: $S \Rightarrow AB \mid AC$ $A \Rightarrow aAb \mid \epsilon$ $B \Rightarrow bA \mid \epsilon$ $C \Rightarrow bCa$ $D \Rightarrow AB$ i) Eliminating useless productions ii) Eliminating unreachable productions ii) Eliminating ϵ -production		10	CO1	L3
PART- C					
5	show that the languages are closed under union, concatenation, star closure, intersection and complement.		10	CO2	L2
OR					
6	(i) State and prove the pumping lemma theorem. (ii) Show that the given grammar are not regular: a) $L = \{ a^n b^n \mid n \geq 0 \}$ b) $L = \{ a^n \mid n \geq 0 \}$		10	CO2	L2



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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSESSMENT: COGNITIVE LEVEL MAPPING

ACADEMIC YEAR: 2022-2023

Course Title	AUTOMATA THEORY AND COMPUTABILITY		
Course Code	18CS54		
Semester	V	IA Test:	II

Q No	Level of questions (RBT)	Marks	(Course Outcome)	Remarks
1.a	L3	10	CO2	
1.b	L3	10	CO2	
2.a	L3	10	CO2	
2.b	L3	10	CO2	
3.a	L2	10	CO3	
3.b	L3	10	CO3	
4.a	L2	10	CO3	
4.b	L3	10	CO3	
5	L2	10	CO2	
6	L2	10	CO2	
	Total:	100		


Name & Signature of Course Instructor:

CO Coverage Details:


CO	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
2	60/100	60	
3	40/100	40	

RBTL Details:

Level (RBT)	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
L2	40/100	40	
L3	60/100	60	


ACADEMIC AUDIT COMMITTEE


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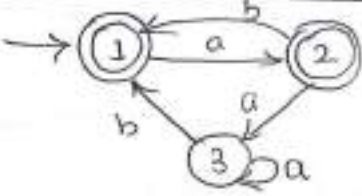
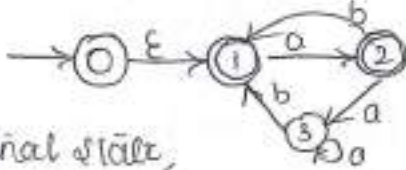
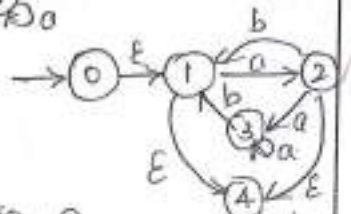

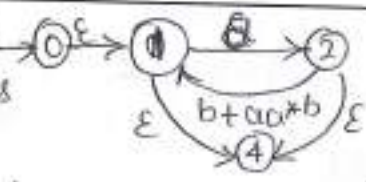
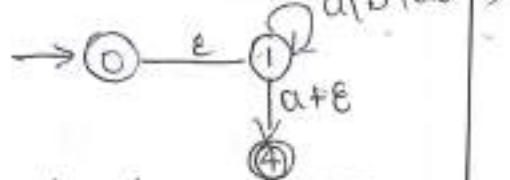
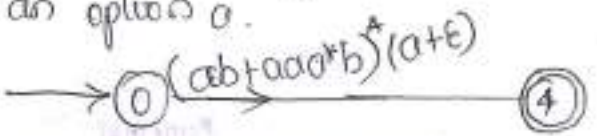
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

V Semester B.E. Degree Second Internal Assessment, DEC 2022

Scheme and Solution

Course Title: AUTOMATA THEORY AND COMPUTABILITY

Course Code: 18CS54


Question No.	Scheme and Solution	Marks
1 a)	<p></p> <p><u>Step 1:</u> state 1 is the start state & it has some incoming edges. so, let us have new start state 0, from state 0 to state 1 on ϵ-transition as shown.</p> <p></p> <p><u>Step 2:</u> Since there are 2 final states, we introduce new final state 4 with ϵ-transitions from state 1 & state 2 as follows:</p> <p></p> <p><u>Step 3:</u> the state 3 can be removed by inserting a transition from state 2 to state 1 with the label aa^*b as:</p> <p></p>	10 M
	<p><u>Step 4:</u> The two arrows from state 2 to state 1 can be written as follows:</p> <p></p> <p><u>Step 5:</u> The state 2 can be removed by having self loop at state 1</p> <p></p> <p><u>Step 6:</u> The state 1 can be removed by having a pattern $a(b+aa^*b)^*$ represented zero or more times followed by an option a.</p> <p></p> <p>RE: $(ab+aaab)^*(a+\epsilon)$</p>	

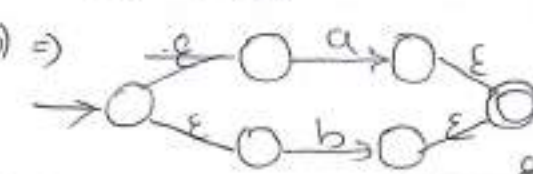
1 b)

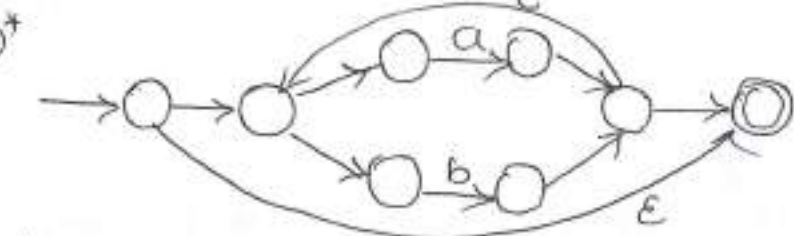
$(a+b)^*aa(a+b)$

10M

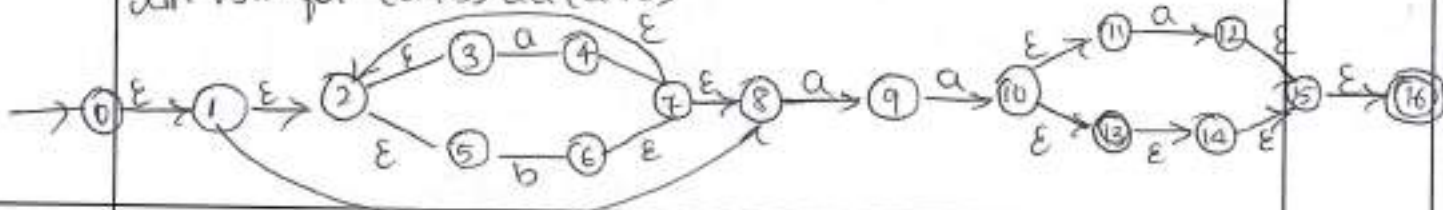
An FSM for $a \Rightarrow$ 

An FSM for $b \Rightarrow$ 

An FSM for $(a+b) \Rightarrow$ 

An FSM for $(a+b)^*$ 

An FSM for $(a+b)^*aa(a+b)$



2 a) i) $L = \{w \mid na(w) \bmod 2 = 0 \text{ where } \{a,b\}^*\}$

5x2=10

$$RE = b^*(aa)^*b^*$$

$\downarrow \quad \downarrow \quad \downarrow$
 $B \quad A \quad B$

$S \rightarrow BAB$

$A \rightarrow aAa \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

or $S \rightarrow aSa \mid \epsilon$
 $S \rightarrow bS \mid \epsilon$

ii) $L = \{w \mid |w| \bmod 3 = 0, \text{ where } w \in \{a,b\}^*\}$
 $L = \{ \epsilon, aaa, bbb, aba, baa, aab, \dots \}$

RE:

$S \rightarrow AAAS \mid \epsilon$

$A \rightarrow a|b$

5

Language is closure under Union:

Let L_1 and L_2 be the regular language, then $L = L_1 \cup L_2$ is also regular.

Example: let $L_1 = \{w \in \{a,b\}^* : w \text{ is the string containing } aa\}$ which is regular
and let $L_2 = \{w \in \{a,b\}^* : w \text{ is the string containing } bb\}$ which is also regular,
Then $L = L_1 \cup L_2$ is regular i.e. $L = \{w \in \{a,b\}^* : w \text{ is the string that contains } aabb\}$ is regular.

Language is closure under concatenation:

Let L_1 and L_2 be the regular language, then $L = L_1 L_2$ is also regular.

Example: let $L_1 = \{w \in \{a,b\}^* : w \text{ is the string that accepts } a\}$ which is regular
and let $L_2 = \{w \in \{a,b\}^* : w \text{ is the string that accepts } b\}$ which is also regular,
then $L = L_1 L_2$ is also regular. $L = \{w \in \{a,b\}^* : w \text{ is the string that } ab\}$ is regular.

Language is closure under Kleene star:

Let L_1 be the regular language, then $L = L_1^*$ is also regular.

Example: let $L_1 = \{w \in \{a,b\}^* : w \text{ is the string that accepts } a\}$ which is regular.

Then $L = L_1^*$ is regular. $L = \{w \in \{a,b\}^* : w \text{ is the string that accepts zero or more occurrences of } a\}$.

Language is closure under Complement:

- Let L_1 be the regular language then there exists a DFMSM M_1 that accepts it.
- Then DFMSM M_2 namely M_1 with accepting and non- accepting states swapped.
- $L(M_2) = \neg(L(M_1))$ because M_2 rejects all strings that M_1 accepts and accepts all strings that M_1 rejects.
- Example: let $L_1 = \{w \in \{a,b\}^* : w \text{ is the string that starts with } a\}$, which is regular, then there exists $L_2 = \{w \in \{a,b\}^* : w \text{ is the string that does not start with } a\}$ which is also regular.
 $L_2 = \neg L_1$.

Language is closure under Intersection:

- We note that $L(M_1) \cap L(M_2) = \neg(\neg(L(M_1)) \cup \neg(L(M_2)))$.
- Since the regular languages are closed under Union and Complement they are also closed under intersection.
- Example: let $L_1 = \{w \in \{a,b\}^* : w \text{ is the string starts with } a\}$ which is regular,
and let $L_2 = \{w \in \{a,b\}^* : w \text{ is the string starts with } b\}$ which is also regular,

Then $L = L_1 \cap L_2$; $L = \{\epsilon\}$ is regular.

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6 (i)	<p>Theorem: Let L be a regular language. Then there exists a constant 'c' such that for every string w in L :</p> $ w \geq c$ <p>We can break w into three strings, $w = xyz$, such that -</p> <ul style="list-style-type: none"> • $y > 0$ or $y \neq \epsilon$ • $xy \leq c$ • For all $k \geq 0$, the string xy^kz is also in L. <p>Proof:The strategy used to prove that certain language is not regular is shown below: Step 1: assume that the language L is regular and n be the number of states of FA. Step 2:select string w such that $w \geq n$ and break it into substrings x,y,and z so that $w=xyz$ with the conditions:</p> <ul style="list-style-type: none"> • $y > 0$ or $y \neq \epsilon$ • $xy \leq n$ <p>Step 3: find any k such that xy^kz is not in L i.e, $xy^kz \notin L$.</p> <p>Steps to prove Language is not regular by contradiction method:</p> <ul style="list-style-type: none"> • At first, we have to assume that L is regular. • So, the pumping lemma should hold for L. • Use the pumping lemma to obtain a contradiction - <ul style="list-style-type: none"> o Select w such that $w \geq n$ o Select y such that $y \geq 1$ o Select x such that $xy \leq n$ o Assign the remaining string to z. o Select k such that the resulting string xy^kz is not in L. 	4M
(ii) a)	<p>$L = \{ a^n b^n \mid n \geq 0 \}$ is not regular</p> <p>Step1: Let L is Regular and n be the number of states in FA, consider the string $w=a^n b^n$</p> <p>Step2: since $w =2n \geq n$, so we can split w into xyz such that $xy \leq n$ and $y > 0$</p> $w = \underbrace{aaaaaa}_x a \underbrace{bbbbbb}_z$ <p>Where $x =n-1$ and $y =1$ so that $xy = x + y =n-1+1=n$ and $w =n$.</p> <p>Step3: Choose a value for i such that $xy^i z$ is not in L.</p> <p>If $i=0$, the string y does not appear and so number of a's will be less than number of b's. So, the string w does not n number of a's followed by n number of b's. Which is contradiction to the language is regular. So $L = \{ a^n b^n \mid n \geq 0 \}$ is not regular</p>	3M
b)	<p>$L = \{ a^n \mid n \geq 0 \}$ is not regular .</p> <p>Step 1: Let L is regular and n be the number of states in FA.</p> <p>Step 2:Let $w = a^n$. It is clear that $w \geq n$. So we can split w into xyz such that $xy \leq n$ and $y > 0$. As shown below:</p> $w = a^n = \underbrace{a^j}_x \underbrace{a^k}_y \underbrace{a^{n-j-k}}_z$ <p>Where $x =j$ and $y =k \geq 1$ and so that $xy = x + y =j+k \leq n$.</p> <p>Step 3:according to pumping lemma $xy^i z \in L$ fro $i=0,1,2,3,\dots$ i.e., $a^j (a^k)^i a^{n-j-k} \in L$</p> <p>So choose $i=0$, it means that $a^j a^{n-j-k} \in L \Rightarrow a^{n-k} \in L$</p> <p>It is clear that $n! > n! - k$, now $k=1$, $n! > n! - 1$ which is not and is contradiction so $L = \{ a^n \mid n \geq 0 \}$ is not regular.</p>	3M

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4 a)

Ambiguous grammar: A grammar is ambiguous if & only if for each string there exists one or more parse tree.

2x5

i) $S \rightarrow AB | bA$
 $A \rightarrow aS | bAA | a$
 $B \rightarrow bS | aBB | b$

considers a string "aaabbb"

LMD: $S \rightarrow AB \rightarrow aSB \rightarrow aABBB \rightarrow aaBBB \rightarrow aaabbb$



∴ Two different parse tree for given string
 ∴ Grammar is ambiguous

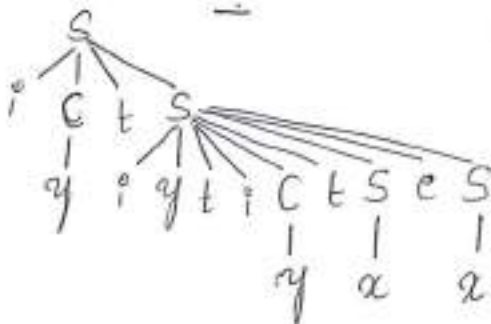
RMD: $S \rightarrow AB \rightarrow AaBB \rightarrow AaBBb \rightarrow AaaBbb \rightarrow Aaabbb \rightarrow aaabbb$

ii) $S \rightarrow iCTs | iCTsEs | x$
 $C \rightarrow y$

considers a string: iytytrea

LMD: $S \rightarrow iCTs \rightarrow iyts \rightarrow iytiCTsEs \rightarrow iytytrea$

RMD: $S \rightarrow iCTsEs \rightarrow iytsEs \rightarrow iytiCTsEs \rightarrow iytytrea$



∴ For the string, there are two parse tree so given grammar is ambiguous.

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4. b)

$$S \rightarrow AB|AC$$

$$A \rightarrow aAb|E$$

$$B \rightarrow bA|E$$

$$C \rightarrow bCa$$

$$D \rightarrow AB$$

i) Eliminating useless productions:

There are no such a productions of the form $X \rightarrow a$, so no need of simplifying the grammar.

ii) Eliminating Unreachable productions:

$$S \rightarrow AB|AC \quad / \text{ both } A, B, C \text{ are reachable}$$

$$A \rightarrow aAb|E$$

$$B \rightarrow bA|E$$

$$C \rightarrow bCa$$

iii) Eliminating ϵ -production:

$$\text{Step 1: } A \rightarrow E$$

$$B \rightarrow E$$

$$\epsilon \{A, B\}$$

$$\text{Step 2: } S \rightarrow AB$$

$$D \rightarrow AB$$

$$\{A, B, S, D\}$$

Step 3: Generated grammar after ϵ -Elimination:

$$S \rightarrow AB|A|B|AC|C$$

$$A \rightarrow aAb|ab$$

$$B \rightarrow bA|b$$

$$C \rightarrow bCa$$

$$D \rightarrow AB|A|B$$

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2. b)	<p> $S \rightarrow aT$ $T \rightarrow bT$ $T \rightarrow a$ $W \rightarrow \epsilon$ $W \rightarrow aT$ </p> <p> <u>step 1:</u> $\rightarrow (S) \quad (T) \quad (W)$ <u>step 2:</u> $\rightarrow (S) \xrightarrow{a} (T) \quad (W)$ <u>step 3:</u> $\rightarrow (S) \xrightarrow{a} (T) \xrightarrow{b} (T) \quad (W)$ <u>step 4:</u> $\rightarrow (S) \xrightarrow{a} (T) \xrightarrow{b} (T) \xrightarrow{a} (F) \quad (W)$ <u>step 5:</u> $\rightarrow (S) \xrightarrow{a} (T) \xrightarrow{b} (T) \xrightarrow{a} (W) \quad (F)$ <u>step 6:</u> $\rightarrow (S) \xrightarrow{a} (T) \xrightarrow{b} (T) \xrightarrow{a} (W) \quad (F)$ <u>step 7:</u> $\rightarrow (S) \xrightarrow{a} (T) \xrightarrow{b} (T) \xrightarrow{a} (W) \quad (F)$ </p> <p> $RE : ab^*(a+a)^*a$ </p>	10 M
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3 a)	<p>Context Free grammar: A context free grammar G is a quadruple: (V, Σ, R, S) where</p> <ul style="list-style-type: none"> $V \rightarrow$ set of Non-terminal $\Sigma \rightarrow$ set of Terminals $R \rightarrow$ rules of the form $x \rightarrow y$ $S \rightarrow$ start symbol <p> $L = \{ a^i b^j c^k : i = j+k, j, k \geq 0 \}$ </p> <p>on substituting $i = j+k$, the language can be written as:</p> $L = \{ a^{j+k} b^j c^k, a^{j+k} b^j c^k \}$ $= \{ a^j a^k b^j c^k \}$ $= \{ a^j b^j a^k c^k \}$ <p> $S \rightarrow AB$ $A \rightarrow aAb \mid \epsilon$ $B \rightarrow aBc \mid \epsilon$ </p>	2+2x4=10
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3 a) $L = \{ 0^n 1^n : n \geq 1 \}$

$S \rightarrow OS1 \mid 01$

3 b)

$E \rightarrow E * T \mid T$

$T \rightarrow F - T \mid F$

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

$L = 0 - ((1 * 0) - 0)$

$LMD \xrightarrow{E} I \rightarrow E - T \rightarrow 0 - F \rightarrow 0 - (E) \rightarrow 0 - (T) \rightarrow 0 - (F - T) \rightarrow 0 - ((E) - T)$
 $\rightarrow 0 - ((E * T) - T) \rightarrow 0 - ((T * T) - T) \rightarrow 0 - ((F * F) - F)$
 $\rightarrow 0 - ((1 * 0) - 0)$

$RMD \xrightarrow{E} T \rightarrow F - T \rightarrow F - F \rightarrow F - (E) \rightarrow F - (T) \rightarrow F - (F) \rightarrow F - ((E) - T)$
 $\rightarrow F - ((E) - F) \rightarrow F - ((E) - 0) \rightarrow F - ((E * T) - 0)$

$\rightarrow F - ((T * F) - 0)$
 $\rightarrow F - ((1 * 0) - 0)$




 Course Instructor


 Domain Co-Ordinator


 Head of Department
 H.O.D. - Computer Science & Engineering
 A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY
 Mangaluru - 575 006, D.K., Karnataka

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USN

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
Fifth Semester BE-Internal Assessment-3, January 2023**AUTOMATA THEORY AND COMPUTABILITY**Duration: 1.30 hrs
Date:21/01/2023Max.Marks:50
Time: 9:00 AM-10:30AM**Note: 1. Answer any three full questions, selecting at least ONE question from each part.**

Part A (20 MARKS)		COs	Marks	RBT												
1.a.	Define PDA? Explain the concept of subroutine with appropriate example.	CO 4	10	L2												
1.b.	Design a Turing machine that accept the language 0^n1^n where $n \geq 1$ and transition ID for the string "000111"	CO 4	10	L3												
OR																
2.a.	Define Multiple track and Multi Tape Turing Machine with example? Show that every language accepted by a multi tape TM is accepted by standard TM with single tape.	CO 4	10	L2												
2.b.	Design a Turing machine that accept the language $0^n1^n2^n$ where $n \geq 1$ and transition ID for the string "001122"	CO 4	10	L3												
Part B (20 MARKS)																
3.a.	Explain Halting Problem? show that halting problem of Turing Machine is undecidable.	CO 5	10	L2												
3.b.	Write a short on: (i)Decidable Languages (ii)Recursively Enumerable languages	CO 5	10	L2												
OR																
4.a.	Explain Post Correspondence problem? Find PC-solution for the following: X: <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>B</td><td>C</td><td>CA</td><td>ABC</td></tr><tr><td>CA</td><td>AB</td><td>A</td><td>C</td></tr></table> Y: <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>CA</td><td>AB</td><td>A</td><td>C</td></tr></table>	B	C	CA	ABC	CA	AB	A	C	CA	AB	A	C	CO 5	10	L2
B	C	CA	ABC													
CA	AB	A	C													
CA	AB	A	C													
4.b.	Write a short on:(i) Growth rate of functions (ii) church-Turing Hypothesis	CO 5	10	L2												
Part C (10 MARKS)																
5	Convert the following grammar into CNF. $S \rightarrow aAcA$ $A \rightarrow B a$ $B \rightarrow C c$	CO 3	10	L3												

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OR				
6	Define Push Down Automata? Construct PDA for the following grammars and also show the ID's for accepting and rejecting cases. (i) $L = \{n_a(w) = n_b(w), n \geq 1, w \in \{a, b\}^*\}$ (ii) $L = \{ww^R \mid w \in \{a, b\}^*\}$	CO 3	10	L3

Course Instructor

Domain Coordinator

IA Coordinator

Academic Audit Committee Member

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ASSESSMENT: COGNITIVE LEVEL MAPPING

ACADEMIC YEAR: 2022-2023

Course Title	AUTOMATA THEORY AND COMPUTABILITY		
Course Code	18CS54		
Semester	V	IA Test:	III

Q No	Level of questions (RBT)	Marks	(Course outcome)	Remarks
1.a	L2	10	CO4	
1.b	L3	10	CO4	
2.a	L2	10	CO4	
2.b	L3	10	CO4	
3.a	L2	10	CO5	
3.b	L2	10	CO5	
4.a	L2	10	CO5	
4.b	L2	10	CO5	
5.a	L3	10	CO3	
6.a	L3	10	CO3	
	Total:	100		

Name & Signature of Course Instructor: *Mrs Vidya Myagasi*

CO Coverage Details:

CO	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
CO3	20	20%	
CO4	40	40%	
CO5	40	40%	

RBTL Details:

Level (RBT)	Total marks for each level/Total Marks (--/100)	% of Marks	Remarks
L3	40	40%	
L4	60	60%	

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING Fifth Semester BE-Internal Assessment-3, January 2023

AUTOMATA THEORY AND COMPUTABILITY

Duration: 1.30 hrs

Max.Marks:50

Date:21/01/2023

Time: 9:00 AM-10:30AM

Note: 1. Answer any three full questions, selecting at least ONE question from each part

Part A (20 MARKS)														
1.a.	Define PDA? Explain the concept of subroutine with appropriate example.	10 Marks												
1.b.	Design a Turing machine that accept the language 0^n1^n where $n \geq 1$ and transition ID for the string "000111"	10Marks												
OR														
2.a.	Define Multiple track and Multi Tape Turing Machine with example? Show that every language accepted by a multi tape TM is accepted by standard TM with single tape.	10 Marks												
2.b.	Design a Turing machine that accept the language $0^n1^n2^n$ where $n \geq 1$ and transition ID for the string "001122"	10 Marks												
Part B (20 MARKS)														
3.a.	Explain Halting Problem? show that the halting problem of the Turing Machine is undecidable.	10 Marks												
3.b.	Write a short on: (i)Decidable Languages (ii)Recursively Enumerable languages	10 Marks												
OR														
4.a.	Explain Post Correspondence problem? Find PC-solution for the following: X: <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>B</td><td>A</td><td>CA</td><td>ABC</td></tr><tr><td>CA</td><td>AB</td><td>A</td><td>C</td></tr></table> Y: <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>CA</td><td>AB</td><td>A</td><td>C</td></tr></table>	B	A	CA	ABC	CA	AB	A	C	CA	AB	A	C	10 Marks
B	A	CA	ABC											
CA	AB	A	C											
CA	AB	A	C											
4.b.	Write a short on:(i) Growth rate of functions (ii) church-Turing Hypothesis	10 Marks												

Part C (10 MARKS)

5	Convert the following grammar into CNF. $S \rightarrow aACa$ $A \rightarrow B \mid a$ $B \rightarrow C \mid c$ $C \rightarrow Cc \mid \epsilon$	10 Marks
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OR

6	Define Push Down Automata? Construct PDA for the following grammars and also show the ID's for accepting and rejecting cases. (i) $L = \{n_a(w) = n_b(w), n \geq 1, w \in \{a, b\}^*\}$ (ii) $L = \{ww^R \mid w \in \{a, b\}^*\}$	10 Marks
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5-12-22
26-12-22
-1-1-22
14-1-22
20-1-22

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
Fifth Semester BE-Internal Assessment-3, January 2023
AUTOMATA THEORY AND COMPUTABILITY(18CS54)
SCHEME OF EVALUATION

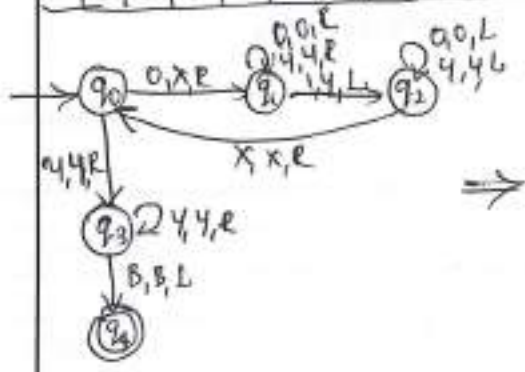
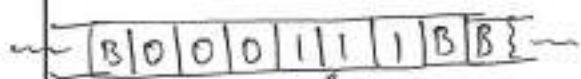
Duration:-90 Min

Max. Marks: 50

Table with 3 columns: Sl. No, Question, Marks. Row 1: a) Define PDA? Explain the concept of subroutine with appropriate example. A PDA can be formally described as a 7-tuple (Q, Σ, S, δ, q0, F) - [List of 7 items]. Subroutine :- [Handwritten explanation of subroutines in TM]. Example: TM to multiply two binary numbers separated by the delimiter 1. Soln: Consider 2x3=6. This is represented as 00x000 -> 000000. [Handwritten state transition diagram for a TM multiplying 00 by 000].

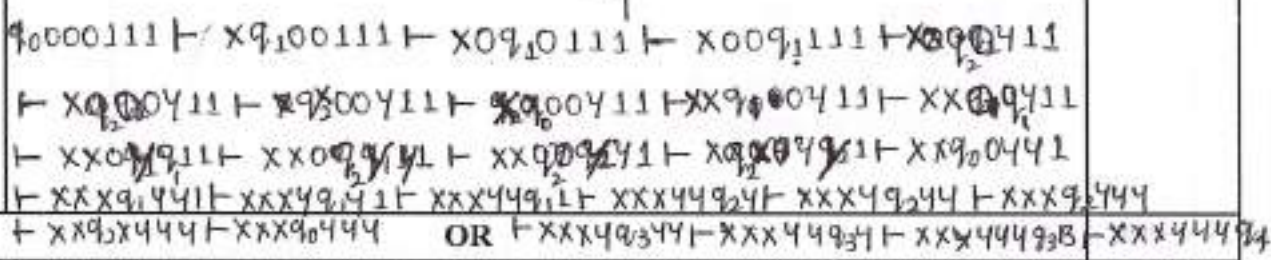
1 b) Design a Turing machine that accept the language $0^n 1^n$ where $n \geq 1$ and transition ID for the string "000111" 10

$$L = \{01, 0011, 000111, \dots\}$$



	0	1	X	Y	B
q ₀	q ₁ , X, R	-	-	q ₃ , Y, R	-
q ₁	q ₁ , 0, R	q ₂ , 1, L	-	q ₁ , Y, R	-
q ₂	q ₂ , 0, L	-	q ₀ , X, R	q ₂ , 1, R	-
q ₃	-	-	-	q ₃ , Y, R	q ₄ , B, L
q ₄	-	-	-	-	-

Input string \Rightarrow 000111



2 a) Define Multiple track and Multi Tape Turing Machine with example? Show that every language accepted by a multi tape TM is accepted by standard TM with single tape. 10

Multiple track TM:-

- \rightarrow In standard TM only one tape was used to store the data.
- \rightarrow In multiple track TM, a single tape is assumed to be divided into a no. of tracks.
- \rightarrow In standard TM, a tape symbol denoted as Γ , in multiple track TM, a tape symbol denoted as Γ^* .

Eg:

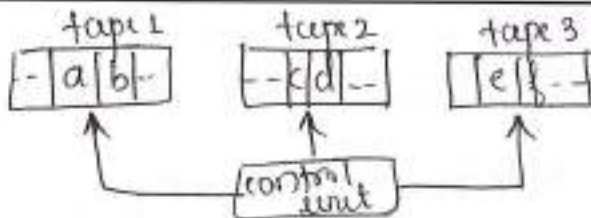
a	0	1	2		
b	1	1	4		
c	0	0	2		
d	1	1	u		

Multi Tape TM :-

- \rightarrow Is a standard TM with more number of tapes.
- \rightarrow Each tape is controlled independently with independent R/W head.

$$M = (Q, \Sigma, \Gamma^*, \delta, q_0, F, B)$$

$$\delta: Q \times \Sigma \times \Gamma^* \rightarrow Q \times \Gamma^* \times \{L, R\} \times S$$



* Each tape divided into cells & holds only one symbol.

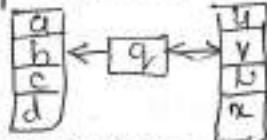
* TM should start state q_0 .

- * The RW head pointing to Tape 1 \rightarrow move right
- " " " " " Tape 2 \rightarrow move right/left
- " " " " " Tape 3 \rightarrow " " "

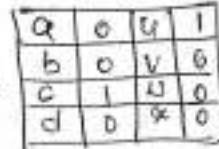
Theorem: Every lang accepted by a multi tape TM is accepted by standard TM with single TM.

proof:

considers



simulated with single tape



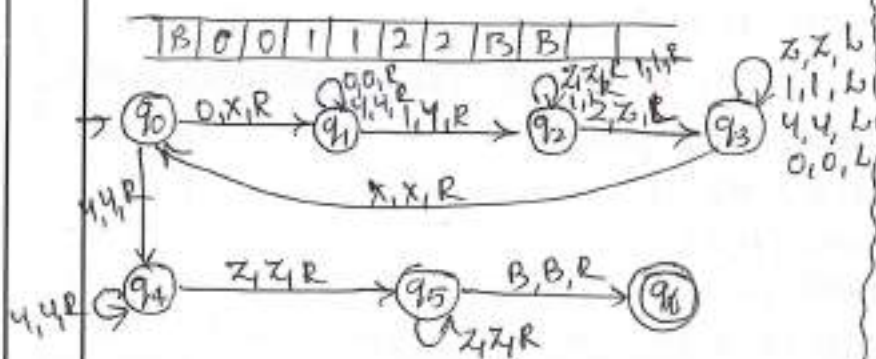
single tape with multiple track

- \rightarrow columns one & three in single tape TM indicates symbol
- \rightarrow column 2 & 4 represents position of RW head
- \rightarrow when m/c in state q , first RW points to c & second RW points to u. \rightarrow TM enter from one state to another, if there exists transition for TM \bar{c} multi tapes.

2 b) Design a Turing machine that accept the language $0^n 1^n 2^n$ where $n \geq 1$ and transition ID for the string "001122"

10

$$L = \{0^n 1^n 2^n \mid n \geq 1\}$$



	0	1	2	X	Y	Z	B
q_0	q_0, X, R	-	-	-	q_2, Y, R	-	-
q_1	$q_1, 0, R$	q_2, Y, R	-	-	q_2, Y, R	-	-
q_2	-	$q_2, 1, R$	q_3, Z, R	-	-	q_2, Z, R	-
q_3	$q_3, 0, L$	$q_3, 1, L$	-	q_0, X, R	q_3, Y, L	q_3, Z, L	-
q_4	-	-	-	-	q_4, Y, R	q_5, X, R	-
q_5	-	-	-	-	-	q_5, Z, R	q_6, B, R
q_6	-	-	-	-	-	-	-

Input string \Rightarrow 001122

$q_0 001122 \vdash x q_1 01122 \vdash x 0 q_1 1122 \vdash x 04 q_2 122 \vdash x 041 q_2 22$
 $\vdash x 04 q_3 1z2 \vdash x 0 q_3 1z2 \vdash x q_3 041z2 \vdash q_3 x 041z2$
 $\vdash x q_0 041z2 \vdash x x q_1 1z2 \vdash x x 4 q_1 1z2 \vdash x x 4 q_2 z2$
 $\vdash x x 4 q_2 z2 \vdash x x 4 q_3 z2 \vdash x x 4 q_3 y z z \vdash x x q_3 4 y z z$
 $\vdash x q_3 x 4 y z z \vdash x x q_0 4 y z z \vdash x x 4 q_4 y z z \vdash x x 4 q_4 z z$
 $\vdash x x 4 q_4 z z \vdash x x 4 q_5 z z \vdash x x 4 q_5 B \vdash x x 4 q_6 z z$

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PART B(20 MARKS)

<p>3</p>	<p>a) Explain Halting Problem? show that the halting problem of the Turing Machine is undecidable.</p> <p>→ Halting problem may be undecidable problem. i.e. it may go infinite loop.</p> <p>Def: If M is a TM, we have to identify whether (M, w) halts or does not halt when w is applied as input.</p> <p>→ Alan Turing in 1936 proved that halting problem is undecidable.</p> <p>proof: Let $L_{HALT} = \{ (M, w) : \text{The TM } M \text{ halts on input } w \}$ is undecidable.</p> <p>proof: Let L_{HALT} is decidable & get a contradiction.</p> <p>Let M_1 is TM such that $L(M_1) = L_{HALT}$.</p> <p>Let us construct TM M_2 as follows:</p> <ul style="list-style-type: none"> 1) For TM M_2 (M, w) is input 2) For TM M_1 acts on (M, w) 3) If TM M_1 rejects (M, w), then TM M_2 rejects (M, w) 4) If TM M_1 accepts (M, w), means TM M simulates the $\forall p$ string w until M halts. 5) If TM M accepted w, TM M_2 accepts (M, w) otherwise rejects. <p>We can observe the following points:</p> <ul style="list-style-type: none"> 1) when M_1 accepts (M, w), the TM M halts on w 2) In step 5, M_2 accepts (M, w) 3) In step 6, M_2 rejects (M, w) <p>∴ The TM M halts on given input w is undecidable</p>	<p>10</p>
<p></p>	<p>b) Write a short on: (i) Decidable Languages (ii) Recursively Enumerable languages</p> <p>1) A decidable lang with yes/no answer is decidable iff the corresponding lang is recursive.</p> <p>→ A decidable lang is a recursive lang with yes/no answer.</p> <p>→ otherwise, it is undecidable lang.</p> <p><u>Theorem</u>: DFA is decidable. Let $M = (Q, \Sigma, \delta, q_0, F)$ be a DFA</p> <ul style="list-style-type: none"> → construct TM, which accepts $L(M)$ & halts. → DFA always ends in some state after reading the string w. construct TM M', that simulates DFA as shown below. → If w is the string scanned by DFA M, the (M, w) is input to M'. 	<p>10</p>

- 2. TM M' checks whether input (M, w) is valid or invalid
 - If (M, w) is valid, write the initial state q_0 & left most symbol of w & reads the next symbol.
 - If (M, w) is invalid, the TM M' rejects (M, w) & halts.
 - If simulation ends in final state of M , then TM' accepts w .
 - If " " " non " " " " " " " " rejects w .

ii) Recursively Enumerable languages :-

- A lang $L \subseteq \Sigma^*$ is RE, iff there exists a TM M such that $L = T(M)$ where $T(M)$ is the lang. accepted by TM.
- A lang $L \subseteq \Sigma^*$ is RE, iff there exists a TM that satisfies 2 conditions:
 - If $w \in L$, w accepted by TM on reaching final state & machine halts.
 - If $w \notin L$, w rejected " " " " " " " " " " " "
- output of the machine may accept or reject → this problem is called membership problem. i.e. "Given a machine M & a string x , does M accept x ?", the output will be yes/no.
- Given a lang, one may have to identify whether the lang is finite or infinite.
- All such problems have 2 ans: yes/no, accept/reject, finite/infinite
all called decision problems.

OR

4 a) Explain Post Correspondence problem? Find PC-solution for the following:

X:	B	A	CA	ABC
Y:	CA	AB	A	C

10

PC = Problem:

Defn Given two sequences of n strings on some alphabet Σ say $A = w_1, w_2, \dots, w_n$ & $B = v_1, v_2, \dots, v_n$
 We say that there exists PC solution for pair (A, B)
 if there is non empty sequence of integers i, j, k, \dots, k
 such that $w_i w_j \dots w_k = v_i v_j \dots v_k$.

- PCP is a device an algm that will inform us for any (A, B) whether or not there is a PC solution.
- finding solution both A's & B's of i, j, \dots, k values are same.

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X : B A CA ABC

Y : CA AB A C

PG Solution ps : A B CA A ABC

AB CA A AB C

$\Rightarrow \frac{ABCAAABC}{ABCAAABC}$

b) Write a short on: (i) Growth rate of functions
(ii) Church-Turing Hypothesis

10

?) Given two algms to solve the same problem, it is necessary to compare those algms to find out which is more efficient. 2x5=10

→ we normally use big oh notation.

Let $f(n)$ be the time efficiency of an algm & $f(n)$ is said to be $O(g(n))$ denoted by: $f(n) = O(g(n))$.

iff there exists a constant c & positive integer n_0 satisfies the condition

$$f(n) \leq c * (g(n)) \quad \forall n > n_0$$

proof: If the given $f(n) = a_k n^k + a_{k-1} n^{k-1} + \dots - a_1 n + a_0$
Each term is summation of the $a_i n^i$. Since n is n^{th} integer, a particular term is negative only if $a_i < 0$.

$$\therefore |f(n)| = |a_k n^k + a_{k-1} n^{k-1} + \dots - a_1 n + a_0|$$
$$\leq |a_k| n^k + |a_{k-1}| n^{k-1} + \dots + |a_1| n + |a_0|$$
$$\leq n^k \left[|a_k| + \frac{|a_{k-1}|}{n} + \dots + \frac{|a_1|}{n^{k-1}} + \frac{|a_0|}{n^k} \right]$$

$$f(n) \leq c^* n^k \quad \text{where } c^* = "$$

$$f(n) \leq c^* g(n) \quad \forall n > n_0 \quad \text{where } g(n) = n^k \text{ \& } n_0 = 1$$

ii) Defⁿ: Any effective computation or any algm procedure that can be carried out by a human being or a group of human beings or a computer, can be carried out by some TM.

→ To solve any decision problem P , iff there is a TM that answers 'yes', on input $w \in P$ & no for $w \notin P$.

→ Church Thesis - Predicts that it is unable to construct models of computation more powerful than the existing ones.

→ Church Turing Thesis: we cannot go beyond TM or their equivalent. TM is more powerful.

→ There is no mathematically proved & still majority of scientist conducted evidence to accept church thesis.

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PART C(10 MARKS)

5

a)

Convert the following grammar into CNF.

$S \rightarrow aACa$
 $A \rightarrow B|a$
 $B \rightarrow C|c$
 $C \rightarrow Cc|\epsilon$

10M

Step 1: Remove epsilon-productions in the grammar G_1

$C \rightarrow \epsilon$, so $\{B, C\}$

$A \rightarrow \epsilon$, so $\{A, B, C\}$

$G_1' = S \rightarrow aACa|aCa|aAa|aa$

$A \rightarrow B|a$

$B \rightarrow C|c$

$C \rightarrow Cc|c$

Step 2: Remove unit productions in G_1' : $A \rightarrow B$
 $B \rightarrow C$

$\textcircled{A} \rightarrow \textcircled{B} \rightarrow \textcircled{C}$

$B \rightarrow C$: $C \rightarrow Cc|c, B \rightarrow Cc|c$

$A \rightarrow B$: $A \rightarrow Cc|c \therefore A \rightarrow Cc|a|c$

$\therefore G_1'' \rightarrow S \rightarrow aACa|aAa|aCa|aa$
 $A \rightarrow cC|c|a$
 $B \rightarrow cC|c$
 $C \rightarrow cC|c$

Step 3: Remove Mixed productions in G_1''

$A \rightarrow xyz$ or $A \rightarrow xB|zyC$

$G_1''' : S \rightarrow TaACTa|TaATA|TaCTa|TaTa$

$A \rightarrow TcC|Tc|Ta$

$B \rightarrow TcC|Tc$

$Ta \rightarrow Ta \quad Tc \rightarrow C$

$C \rightarrow TcC|Tc$

Step 4: Remove long productions in G_1''' . of the form $A \rightarrow BCDE$

$G_1'''' : S \rightarrow TaS_1|TaS_3|TaS_2|TaTa$

$S_1 \rightarrow AS_2$

$S_2 \rightarrow CTa$

$S_3 \rightarrow ATa$

$A \rightarrow TcC|Ta|Tc$

$B \rightarrow TcC|Tc$

$C \rightarrow TcC|Tc$

$Ta \rightarrow a$

$Tc \rightarrow C //$

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OR

6

a)

Define Push Down Automata? Construct PDA for the following grammars and also show the ID's for accepting and rejecting cases.

10

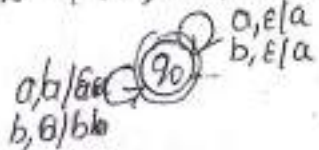
(i) $L = \{n_a(w) = n_b(w), n \geq 1, w \in \{a, b\}^*\}$

(ii) $L = \{ww^n | w \in \{a, b\}^*\}$

10/11

$P(Q, \Sigma, \Gamma, \delta, q_0, F)$: $Q \rightarrow$ Set of finite state
 $\Sigma \rightarrow$ set of input alphabets
 $\Gamma \rightarrow$ set of stack alphabets
 $\delta \rightarrow Q \times (\Sigma \cup \epsilon) \times \Gamma^* \rightarrow Q \times \Gamma^*$
 $q_0 \rightarrow$ initial state
 $F \rightarrow$ set of final state

i) $L = \{n_a(w) = n_b(w), n \geq 1\}$
 $L = \{ab, ba, aabb, abab, baba, \dots\}$

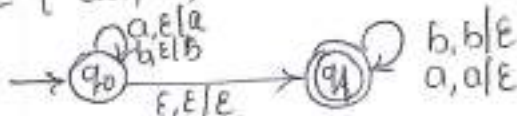


accepting string : $(q_0, abba, \epsilon) \vdash (q_0, bba, a)$
 $\vdash (q_0, bb, ba)$

$\vdash (q_0, \epsilon, \epsilon) \leftarrow$ accepting

Rejecting string : $(q_0, abb, \epsilon) \vdash (q_0, bb, a) \vdash (q_0, b, \epsilon) \leftarrow$ Rejecting

ii) $L = \{aa, bb, abba, baab, \dots\}$



accepting string : $(q_0, abba, \epsilon) \vdash (q_0, bba, a)$
 $\vdash (q_0, ba, ba)$

$\vdash (q_0, a, a) \vdash (q_0, \epsilon, \epsilon)$ accepting

Rejecting string : $(q_0, abab, \epsilon) \vdash (q_0, bab, a)$
 $\vdash (q_0, ab, ba)$

$\vdash (q_0, b, aba)$
 $\vdash (q_0, \epsilon, laba)$ rejecting

Course Instructor

Domain Coordinator

IA Coordinator

Academic Audit Committee Member

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

COURSE CONTENT-DELIVERY DETAILS

Course Title: Automata Theory And Computability

Course Code: 18CS54

Semester: V

Hours/Week: 4

Scheme: 18 scheme

Academic Year: 2022 -2023

Total Lecture Hours: 40

Hours	Topics	Mode	Date of Delivery
1	Strings and languages	Chalk & Talk	7/11/22
2	Language Hierarchy	Chalk & Talk	9/11/22
3	Computation, Finite state machine	Chalk & Talk	9/11/22
4	Deterministic Finite state machine, regular Languages, Designing DFSA	Chalk & Talk	10/11/22
5	Deterministic Finite state machine, regular Languages, Designing DFSA	Chalk & Talk	16/11/22
6	Non-Deterministic Finite machine, RL's, Designing DFSA.	Chalk & Talk	17/11/22
7	Minimizing FSAs	Chalk & Talk	19/11/22
8	Canonical form of RL, Finite state transducers, Bidirectional Transducers.	Chalk & Talk	21/11/22
1	What is RE? Kleene's theorem	Chalk & Talk	21/11/22
2	Applications of REs, Manipulating and simplifying REs	Chalk & Talk	21/11/22
3	Regular grammars: Definition, Regular grammars and Regular languages.	Chalk & Talk	22/11/22
4	Regular grammars: Definition, Regular grammars and Regular languages.	Chalk & Talk	28/11/22
5	Regular Languages (RL) and Nonregular Languages: how many RL's, To show that a language is regular.	Chalk & Talk	29/11/22
6	Regular Languages (RL) and Nonregular Languages: how many RL's, To show that a language is regular.	Chalk & Talk	30/11/22
7	Closure properties of Regular Languages.	Chalk & Talk	1/12/22
8	show that some languages are not RL's	Chalk & Talk	2/12/22



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1	Context Free Grammar(CFG):Introduction to rewrite Systems and Grammars,CFG's and languages.	Chalk & Talk	6/12/22
2	Designing CFGs	Chalk & Talk	7/12/22
3	Designing CFGs	Chalk & Talk	8/12/22
4	Designing CFGs	Chalk & Talk	12/12/22
5	Simplifying CFGs, proving that a Grammar is correct, Derivation and Parse trees	Chalk & Talk	14/12/22
6	Ambiguity	Chalk & Talk	16/12/22
7	Normal Forms,Pushdown Automata(PDA):Definition of non-deterministic PDA,Deterministic and Non-Deterministic PDA's	Chalk & Talk	19/12/22
8	Non-Deterministic and halting,alternative equivalent definitions of PDA, alternative that are not equivalent toPDA.	Chalk & Talk	20/12/22
1	Context Free and Non-context free languages:where do the CFL fits.	Chalk & Talk	26/12/22
2	showing a language is context-free,pumping theorem for CFL	Chalk & Talk	26/12/22
3	Algorithms and decision procedures for CFLs:Decidable questions,Undecidable questions.	Chalk & Talk	27/12/22
4	Turing Machines:Turing Machine model,Representation,languages acceptability by TM.	Chalk & Talk	27/12/22
5	Types of Techniques for TM constructions and variants of TM	Chalk & Talk	29/12/22
6	Design of TM ,Techniques of TM construction	Chalk & Talk	31/12/22
7	Design of TM ,Techniques of TM construction	Chalk & Talk	5/1/23
8	Design of TM ,Techniques of TM construction	Chalk & Talk	9/1/23
1	Variants of TM ,the model of Linear Bounded automata	Chalk & Talk	9/1/23
2	Decidability:definition of an algorithm,decidability	Chalk & Talk	10/1/23
3	Decidable languages: Undecidable languages	Chalk & Talk	12/1/23
4	halting problem of TM, post correspondence problem.	Chalk & Talk	12/1/23
5	Complexity:Growth rate of functions	Chalk & Talk	16/1/23
6	The classes of P and NP	Chalk & Talk	17/1/23



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7	Quantum computation: quantum computers, quantum computers	Chalk & Talk	23/1/23
8	Church-Turing thesis	Chalk & Talk	24/1/23

Textbooks:

T1. Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson education, 2012/2013

T2. K L P Mishra, N Chandrasekaran, 3rd Edition, Theory of Computer Science, PHI, 2012.

Web Reference:

1. <https://www.studocu.com/in/document/sir-mokshagundam-visvesvaraya-institute-of-technology/automata-theory-of-computation/atc/11671263>

2. <https://www.slideshare.net/appasami/cs6503-theory-of-computation-book-notes>

Course Instructor

Domain Co-Ordinator

Head of Department

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ACADEMIC YEAR 2022-23 (Odd Semester)

Name of Course: Automata Theory and Computability

Name of Course Instructor: Mrs. Vidya Myageri

List of students scored less than 20 Marks in IA-1

Sl. No	USN	Name of the student	Marks	Reason for poor performance	Students Signature
1	4JK20CS003	ADITHYAN K V	10	Didnt study	
2	4JK20CS021	KARTHIK H R	11	Not understood topic	
3	4JK20CS024	MANORANJAN.M	16	Didnt study	
4	4JK20CS026	MOHAMMAD AMAN	18	Didnot study	
5	4JK20CS027	MOHAMMED	13	Didnt study	
6	4JK20CS031	NISHAL S. P KARKERA	16	Didnt study	
7	4JK20CS053	VIDYASHREE SHETTY	10	Didnt studied properly.	
8	4JK20CS056	ZAID ALI AHAMAD	8	Didnt study	
9	4JK21CS402	SUSHMA MALLESH KAIKAD	15	Not studied	

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Summary

Conducted a meeting with the students on 03-12-2022 after IA1 to assess the poor performance. The above students have scored less than 20 out of 50 marks in first IA. The reason for scoring less marks is the lack of practice and confusion. Also students have found quite difficult to switch from online mode to physical mode.

Suggestions and Guidelines:

- Instructed the students to be regular in classes.
- Informed about the online study material and resource availability in Google Classroom.
- Students were asked to refer to the previous exam papers to understand the nature of questions appearing in the exam.
- The above mentioned students have been guided to meet the course instructor in personal to clarify any type of doubts.

Course Instructor

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ACADEMIC YEAR 2022-23 (Odd Semester)

Name of Course: Automata Theory and Computability

Name of Course Instructor: Mrs. Vidya Myageri

List of students scored less than 20 Marks in IA-2

Sl. No	USN	Name of the student	Marks	Reason for poor performance	Students Signature
1	4JK20CS003	ADITHYAN K V	4	Didn't study well	
2	4JK20CS004	ADVAITH PRASAD	7	Didn't prepare well	
3	4JK20CS005	AHMAD MIDLAJ B	10	Didn't prepare well	
4	4JK20CS013	CLIVA RHEA MORAS	19	Didn't prepare	
5	4JK20CS020	KARTHIK GANESH	18	Confused with topics	
6	4JK20CS021	KARTHIK H R	9	Not understood the topics	
7	4JK20CS027	MOHAMMED	5	Didn't study	
8	4JK20CS039	RAHUL M MOOLYA	10	Poor utilization of available materials from my side	
9	4JK20CS050	VAISHISHTA	17	felt difficult	
				Didn't study	
10	4JK20CS056	ZAID ALI AHAMAD	8	Didn't study well	
11	4JK21CS402	SUSHMA MALLESH KAIKAD	18	Not study	

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Summary

Conducted a meeting with the students on 07-01-2023 after IA-2 to assess the poor performance.

The above students have scored less than 20 out of 50 marks in IA - 2. The reason for scoring less marks is the lack of practicing the numerical and health issues.

Suggestions and Guidelines:

- The above mentioned students have been guided to meet the course instructor in personal to clarify any type of doubts.
- Instructed the students to be regular in classes.
- Students were asked to refer to the previous exam papers to understand the nature of questions appearing in the exam.
- Also suggested to make use of Library and e-resources available in college website.
- Suggested to keep proper care of physical and mental health.

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

UG IA Marks Application

Hello, 4JKCS

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LOGOUT | (Logout.php)

Dashboard (Dashboard.php) IA Marks Entry (IAMarksEntry.php)

INTERNAL MARKS ENTRY

Semester

5 Semester

SubjectCode

18CS54 - Automata theory and Computability

Choose Faculty

4JKCS0020142 - VIDYA.MYAGERI

GO AHEAD

IA Entry for 18CS54 - Automata theory and Computability

TOTAL

58

SAVED

58

REMAINING

0

NOTE: Please Click on Save Button Before Going To Next Page of Marks Entry.

Show 100 entries

Search:

SlNo.	USN	Student Name	Attendance	Marks Scored	Max Marks	Status
1	4JK20CS001	ABHLASH J Y	Present	35	40	Frozen
2	4JK20CS002	ADARSH VINOD	Present	21	40	Frozen
3	4JK20CS003	ADITHYAN K V	Present	20	40	Frozen
4	4JK20CS004	ADVAITH PRASAD	Present	19	40	Frozen
5	4JK20CS005	AHMAD MIDLAJ B	Present	22	40	Frozen

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Sl.No.	USN	Student Name	Attendance	Marks Scored	Max Marks	Status
6	4JK20CS006	ALISHA UJWALA	Present	37	40	Frozen
7	4JK20CS007	ANANYA G ADYANTHAYA	Present	33	40	Frozen
8	4JK20CS008	ANVITHA	Present	25	40	Frozen
9	4JK20CS009	ANVITHA	Present	34	40	Frozen
10	4JK20CS010	ASHWIN SHETTY	Present	23	40	Frozen
11	4JK20CS011	BHAGYASHREE	Present	29	40	Frozen
12	4JK20CS012	C A PRAJWAL	Present	35	40	Frozen
13	4JK20CS013	CLARA RHEA MORAS	Present	23	40	Frozen
14	4JK20CS014	DEVIPRASAD RAI P	Present	26	40	Frozen
15	4JK20CS015	DHRUV KISHORE SHETTY	Present	31	40	Frozen
16	4JK20CS016	FARZEEN HARI S	Present	23	40	Frozen
17	4JK20CS017	HRITHIK G H	Present	22	40	Frozen
18	4JK20CS018	ISHA BASHIR SHEIK	Present	32	40	Frozen
19	4JK20CS019	JEEVAN M	Present	37	40	Frozen
20	4JK20CS020	KARTHIK GANESH	Present	24	40	Frozen
21	4JK20CS021	KARTHIK H R	Present	18	40	Frozen
22	4JK20CS022	LAKSHMI U KURUBARA	Present	37	40	Frozen
23	4JK20CS023	MANNYA ANNA SAM	Present	31	40	Frozen
24	4JK20CS024	MANORANJAN M	Present	21	40	Frozen
25	4JK20CS025	MANVITH K AMIN	Present	28	40	Frozen
26	4JK20CS026	MOHAMMAD AMAN	Present	27	40	Frozen
27	4JK20CS027	MOHAMMED	Present	19	40	Frozen
28	4JK20CS028	N R NEERAJ	Present	34	40	Frozen
29	4JK20CS029	NAMRATHA SHETTY	Present	34	40	Frozen
30	4JK20CS030	NEHA V P	Present	27	40	Frozen
31	4JK20CS031	NISHAL S P KARKERA	Present	24	40	Frozen
32	4JK20CS032	NISHANTH	Present	40	40	Frozen

Sl.No.	USN	Student Name	Attendance	Marks Scored	Max Marks	Status
33	4JK20CS033	POOJASHREE A S	Present	30	40	Frozen
34	4JK20CS034	PRAKRUTHI S SHETTY	Present	33	40	Frozen
35	4JK20CS035	PRAMYA	Present	37	40	Frozen
36	4JK20CS036	PRATEEK CHANDRASEKAR KOTIAN	Present	31	40	Frozen
37	4JK20CS037	PRATHVI DEWADIGA	Present	36	40	Frozen
38	4JK20CS038	RAHUL D SHETTY	Present	22	40	Frozen
39	4JK20CS039	RAHUL M MOOLYA	Present	20	40	Frozen
40	4JK20CS040	RAMSHA RIYAZ AHMED MIRZANKAR	Present	27	40	Frozen
41	4JK20CS041	S.ATHREYA SHANKAR	Present	34	40	Frozen
42	4JK20CS042	SANNIDHI SHIVAPRASAD RAJ	Present	26	40	Frozen
43	4JK20CS044	SHARATH KUMAR	Present	37	40	Frozen
44	4JK20CS045	SHREYA S SHETTY	Present	30	40	Frozen
45	4JK20CS046	SWASTHIK ACHAR	Present	30	40	Frozen
46	4JK20CS047	THEJASWI D S	Present	39	40	Frozen
47	4JK20CS048	TIKESH RAJ	Present	30	40	Frozen
48	4JK20CS049	VAISHAK	Present	30	40	Frozen
49	4JK20CS050	VAISHISHTA	Present	25	40	Frozen
50	4JK20CS051	VARSHA B SHETTY	Present	36	40	Frozen
51	4JK20CS052	VEENA V R	Present	31	40	Frozen
52	4JK20CS053	VIDYASHREE SHETTY	Present	25	40	Frozen
53	4JK20CS054	VJETH KUMAR	Present	29	40	Frozen
54	4JK20CS055	YASHAS MANJAR	Present	33	40	Frozen
55	4JK20CS056	ZAID ALI AHAMAD	Present	19	40	Frozen
56	4JK21CS400	MOUNA R R	Present	25	40	Frozen
57	4JK21CS401	PRAJNA P	Present	39	40	Frozen
58	4JK21CS402	SUSHMA MALLESH KAIKAD	Present	23	40	Frozen

Showing 1 to 58 of 58 entries

Previous 1 Next

NOTE:

► The values are already Submitted and Frozen

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Principal

A.J. Institute of Engineering & Technology
Mangaluru - 575 006



AJ INSTITUTE OF ENGINEERING & TECHNOLOGY

A Unit of Laxmi Memorial Education Trust

(Approved by AICTE, New Delhi, Affiliated to Visvesvaraya Technological University, Belgaavi)

NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

RESULT ANALYSIS

Academic Year: 2021-22

Semester: 5TH

Total Students	No. of Absentees	Appeared	FCD	FC	SC	PASS	FAIL	Pass %	PI (%)
58	00	58	16	22	12	50	08	86.20	69.82

Course Code	Course Title	Name of Faculty	No of students attended	S	A	B	C	D	E	F	Pass %	PI (%)
18CS51	MANAGEMENT AND ENTREPRENEURSHIP FOR IT INDUSTRY	Mr. VINAYAK G	58	0	8	15	17	17	1	0	100	71.89
18CS52	COMPUTER NETWORKS & SECURITY	Mrs. SNITHA SHETTY Mr. VJAYLUMAR DUDHANIKAR	58	1	4	11	18	17	4	3	94.82	65.68
18CS53	DATABASE MANAGEMENT SYSTEM	Mrs. SHARON D'SOUZA	58	0	2	10	13	28	3	2	96.55	63.96
18CS54	AUTOMATA THEORY & COMPATIBILITY	Mrs. VIDYA MYAGERI	58	2	3	12	18	16	3	4	93.10	65.68
18CS55	APPLICATION DEVELOPMENT USING PYTHON	Mrs. SHARON D'SOUZA	57	1	4	12	17	16	2	5	91.2	63.79
18CS56	UNIX PROGRAMMING	Mrs. VIDYA MYAGERI	58	1	10	12	15	17	3	0	100	71.55
18CSL57	COMPUTER NETWORK LABORATORY	Mrs. Sharon C D'Souza / Mrs. Archana S	58	9	12	14	13	10	0	0	100	79.48
18CSL58	DATABASE MANAGEMENT SYSTEM LABORATORY WITH MINI PROJECT	Mrs. SHARON D'SOUZA	58	13	21	14	10	0	0	0	100	86.37
18CIV59	ENVIRONMENTAL STUDIES	Mrs. PRAFULLA	58	13	21	14	9	0	0	0	100	85.17

Principal

A.J. Institute of Engineering & Technology
Mangaluru - 575 006

Signature of HOD

H.O.D. - Computer Science & Engineering
A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY
Mangaluru - 575 006, D.K., Karnataka

Signature of Class Advisor

A.J. INSTITUTE OF ENGINEERING & TECHNOLOGY MANGALURU
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
RESULT ANALYSIS V SEMESTER 2018-21

Sl.No	ID No	Name	18CS01				18CS02				18CS03				18CS04				18CS05				18CS06				18CS07				18CS08				18CS09				TOTAL	GPA	CENTS
			Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade	Internal	External	Total	Grade							
1	18ECS000001	ABHILASH J Y	23	30	53	C	35	30	65	C	21	41	62	C	28	36	64	C	37	30	67	C	33	32	65	D	37	38	75	A	38	51	89	A	37	48	85	A	88	7.0	85.1
2	18ECS000002	ADARSH VINOD	23	35	58	D	32	35	67	D	20	32	52	D	31	41	72	C	29	30	59	D	20	30	50	D	30	30	60	C	28	48	76	C	30	39	69	C	105	6.4	79.0
3	18ECS000003	ADITHYAN K V	28	38	66	D	29	35	64	D	19	29	48	D	29	34	63	D	33	31	64	C	22	32	54	D	31	33	64	C	31	42	73	C	31	37	68	C	101	6.2	78.1
4	18ECS000004	ADITHYAN PRASAD	16	30	46	D	28	38	66	D	19	29	48	D	19	27	46	D	23	21	44	D	22	32	54	D	28	43	71	C	29	38	67	C	24	32	56	C	101	6.5	80.0
5	18ECS000005	ADITHYAN SRIHARSHITH D	27	32	59	C	30	28	58	D	24	31	55	D	22	34	56	D	24	36	60	C	28	37	65	D	34	36	70	B	34	54	88	A	35	39	74	A	100	6.0	81.7
6	18ECS000006	ADITHYAN SRIKANTH	39	34	73	B	27	41	68	B	34	42	76	B	37	38	75	B	35	32	67	C	36	42	78	C	38	47	85	A	35	50	85	A	37	50	87	A	108	7.1	87.7
7	18ECS000007	ADITHYAN SRIKANTH	34	44	78	B	31	32	63	C	26	37	63	C	32	38	70	C	32	32	64	C	25	32	57	D	35	42	77	C	35	50	85	A	36	39	75	A	104	7.4	86.1
8	18ECS000008	ADITHYAN SRIKANTH	21	30	51	D	27	38	65	C	28	37	65	C	28	37	65	C	28	37	65	C	28	37	65	C	28	37	65	C	28	37	65	C	28	37	65	C	100	6.0	80.0
9	18ECS000009	ADITHYAN SRIKANTH	26	37	63	D	30	38	68	D	24	37	61	D	24	37	61	D	24	37	61	D	24	37	61	D	24	37	61	D	24	37	61	D	24	37	61	D	100	6.0	80.0
10	18ECS000010	ADITHYAN SRIKANTH	34	36	70	B	29	40	69	B	26	37	63	C	33	37	70	C	33	37	70	C	33	37	70	C	33	37	70	C	33	37	70	C	33	37	70	C	100	6.0	80.0
11	18ECS000011	ADITHYAN SRIKANTH	24	34	58	D	21	32	53	D	22	37	59	D	29	32	61	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	100	6.0	80.0
12	18ECS000012	ADITHYAN SRIKANTH	30	38	68	D	35	47	82	B	28	38	66	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	100	6.0	80.0
13	18ECS000013	ADITHYAN SRIKANTH	24	21	45	D	28	38	66	D	23	38	61	D	23	38	61	D	23	38	61	D	23	38	61	D	23	38	61	D	23	38	61	D	23	38	61	D	100	6.0	80.0
14	18ECS000014	ADITHYAN SRIKANTH	24	30	54	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	100	6.0	80.0
15	18ECS000015	ADITHYAN SRIKANTH	27	40	67	A	30	35	65	C	34	32	66	C	31	32	63	C	34	32	66	C	34	32	66	C	34	32	66	C	34	32	66	C	34	32	66	C	100	6.0	80.0
16	18ECS000016	ADITHYAN SRIKANTH	18	27	45	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	100	6.0	80.0
17	18ECS000017	ADITHYAN SRIKANTH	30	38	68	D	35	47	82	B	28	38	66	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	100	6.0	80.0
18	18ECS000018	ADITHYAN SRIKANTH	26	40	66	A	32	38	70	B	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	100	6.0	80.0
19	18ECS000019	ADITHYAN SRIKANTH	28	31	59	D	31	44	75	B	34	44	78	B	37	47	84	A	30	39	69	C	27	32	59	D	31	44	75	B	34	44	78	B	34	44	78	B	100	6.4	79.1
20	18ECS000020	ADITHYAN SRIKANTH	20	31	51	D	30	21	51	D	20	26	46	D	24	39	63	C	28	31	59	D	24	31	55	D	24	31	55	D	24	31	55	D	24	31	55	D	100	6.0	80.0
21	18ECS000021	ADITHYAN SRIKANTH	26	35	61	C	24	27	51	D	30	37	67	D	18	22	40	D	22	22	44	D	21	32	53	D	21	32	53	D	21	32	53	D	21	32	53	D	100	6.0	80.0
22	18ECS000022	ADITHYAN SRIKANTH	25	38	63	B	32	41	73	B	34	34	68	C	32	42	74	A	28	38	66	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	100	6.0	80.0
23	18ECS000023	ADITHYAN SRIKANTH	30	38	68	D	35	47	82	B	28	38	66	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	30	38	68	D	100	6.0	80.0
24	18ECS000024	ADITHYAN SRIKANTH	21	21	42	D	18	24	42	D	30	26	56	D	21	27	48	D	21	27	48	D	21	27	48	D	21	27	48	D	21	27	48	D	21	27	48	D	100	6.0	80.0
25	18ECS000025	ADITHYAN SRIKANTH	28	30	58	D	29	34	63	C	26	27	53	D	26	27	53	D	26	27	53	D	26	27	53	D	26	27	53	D	26	27	53	D	26	27	53	D	100	6.0	80.0
26	18ECS000026	ADITHYAN SRIKANTH	25	25	50	C	25	28	53	D	18	22	40	D	18	22	40	D	18	22	40	D	18	22	40	D	18	22	40	D	18	22	40	D	18	22	40	D	100	6.0	80.0
27	18ECS000027	ADITHYAN SRIKANTH	22	22	44	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	28	38	66	D	100	6.0	80.0
28	18ECS000028	ADITHYAN SRIKANTH	18	24	42	D	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	100	6.0	80.0
29	18ECS000029	ADITHYAN SRIKANTH	32	40	72	B	31	38	69	B	27	35	62	C	34	34	68	C	32	41	73	B	31	38	69	B	31	38	69	B	31	38	69	B	31	38	69	B	100	6.0	80.0
30	18ECS000030	ADITHYAN SRIKANTH	30	48	78	B	30	32	62	C	30	32	62	C	30	32	62	C	30	32	62	C	30	32	62	C	30	32	62	C	30	32	62	C	30	32	62	C	100	6.0	80.0
31	18ECS000031	ADITHYAN SRIKANTH	24	20	44	D	25	28	53	D	28	36	64	D	28	36	64	D	28	36	64	D	28	36	64	D	28	36	64	D	28	36	64	D	28	36	64	D	100	6.0	80.0
32	18ECS000032	ADITHYAN SRIKANTH	35	44	79	B	34	32	66	C	36	43	79	B	40	38	78	B	40	38	78	B	40	38	78	B	40	38	78	B	40	38	78	B	40	38	78	B	100	6.4	79.1
33	18ECS000033	ADITHYAN SRIKANTH	38	52	90	A	33	36	69	B	31	31	62	C	32	33	65	C	32	33	65	C	32	33	65	C	32	33	65	C	32	33	65	C	32	33	65	C	100	6.0	80.0
34	18ECS000034	ADITHYAN SRIKANTH	32	36	68	D	30	30	60	D	30	37	67	D	32	38	70	C	32	38	70	C	32	38	70	C	32	38	70	C	32	38	70	C	32	38	70	C	100	6.0	80.0
35	18ECS000035	ADITHYAN SRIKANTH	36	44	80	A	37	40	77	B	37	40	77	B	37	4																									

SI No	USN	Name	CO 1:	CO 2:	CO 3:	CO 4:	CO 5:
1	4jk20cs001	ABHILASH JY	4	4	4	4	4
2	4JK20CS002	ADARSH VINOD	4	5	5	4	5
3	4JK20CS003	Adithyan k v	4	5	4	4	5
4	4JK20CS004	ADVAITH PRASAD	5	5	5	5	5
5	4JK20CS005	AHMAD MIDLAJ	5	5	5	5	5
6	4JK20CS006	ALISHA	4	4	4	4	4
7	4JK20CS007	ANANYA G ADYANTHAYA	5	5	5	5	5
8	4JK20CS008	ANVITHA	5	4	5	4	5
9	4JK20CS009	ANVITHA	4	4	5	5	4
10	4JK20CS010	ASHWIN SHETTY	5	5	4	5	5
11	4JK20CS011	BHAGYASHREE	4	3	3	4	4
12	4JK20CS012	C A PRAJWAL	5	5	5	5	5
13	4JK20CS013	CLIVA	4	5	5	5	5
14	4JK20CS014	DEVIPRASAD RAI P	5	4	4	5	5
15	4jk20cs015	DHRUV KISHORE SHETTY	5	5	5	5	5
16	4JK20CS016	FARZEEN HARIS	5	5	5	5	5
17	4JK20CS017	HRITHIK G H	5	4	3	4	4
18	4JK20CS018	ISHA SHEIKH BASHIR	5	5	5	5	5
19	4jk20cs019	JEEVAN	5	5	5	5	5
20	4JK20CS020	KARTHIK GANESH	4	4	4	3	4
21	4JK20CS021	KARTHIK HR	4	4	5	5	5
22	4JK20CS022	LAKSHMI U KURUBARA	4	5	4	5	4
23	4JK20CS023	MANNYA ANNA SAM	5	4	4	5	4
24	4JK20CS024	MANORANJAN M	5	5	5	5	5
25	4JK20CS025	MANVITH K AMIN	5	5	5	5	5
26	4JK20CS026	MOHAMMAD AMAN	4	4	4	4	4
27	4JK20CS027	MOHAMMED	5	5	5	5	5
28	4JK20CS028	N R NEERAJ	5	5	4	5	5
29	4JK20CS029	NAMRATHA SHETTY	4	4	4	4	4
30	4JK20CS030	NEHA VP	4	5	4	5	3
31	4JK20CS031	NISHAL S.P KARKERA	4	5	5	5	4
32	4jk20cs032	NISHANTH	5	5	5	5	5
33	4JK20CS033	Poojashree	5	5	5	5	5
34	4JK20CS034	PRAKRUTHI S SHETTY	5	5	5	5	5
35	4JK20CS035	PRAMYA	5	4	4	5	5
36	4JK20CS036	PRATEEK C KOTIAN	4	5	4	5	5
37	4JK20CS037	PRATHVI DEVADIGA	5	4	5	4	5
38	4JK20CS038	RAHUL SHETTY	4	5	5	4	3
39	4JK20CS039	RAHUL M MOOLYA	4	4	4	4	4
40	4JK20CS040	RAMSHA RIYAZ	5	4	3	3	3
41	4JK20CS041	S. ATHREYA SHANKAR	5	5	4	4	4
42	4JK20CS042	SANNIDHI S RAI	5	5	5	5	5
43	4JK20CS044	SHARATH KUMAR	5	5	5	5	5
44	4JK20CS045	Shreya S Shetty	5	5	5	4	4
45	4JK20CS046	SWASTHIK ACHAR	5	5	5	4	4
46	4JK20CS047	THEJASWI. D. S	5	5	5	4	4
47	4JK20CS048	TIKESHRAJ	5	5	5	5	5
48	4JK20CS049	VAISHAK	5	5	5	5	5
49	4jk20cs050	VAISHISHTA	4	3	4	5	4
50	4jk20cs051	VARSHA B SHETTY	5	5	5	5	5
51	4jk20cs053	Vidyashree Shetty	4	4	5	5	5
52	4JK20CS054	VIJETH KUMAR	4	4	3	4	4
53	4jk20cs055	YASHAS MANJAR	4	4	4	4	4
54	4JK20CS056	ZAID ALI AHAMAD	5	5	5	5	4
55	4JK21CS400	MOUNA RR	5	5	5	5	5
56	4JK21CS401	PRAJNA P	5	5	5	5	5

57	4jk21cs402	SUSHMA MALLESH KAIKAD	4	4	5	5	4
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	CO1	CO2	CO3	CO4	CO5
5-EXCELLENT COUNT	35	36	35	37	33
4-VERY GOOD COUNT	22	19	18	18	21
3-GOOD COUNT	0	2	4	2	3
2-SATISFACTORY COUNT	0	0	0	0	0
1-NEEDS IMPROVEMENT COUNT	0	0	0	0	0
NUMBER OF STUDENTS	57	57	57	57	57
TOTAL (5 EXCELLENT) + (4 VERY GOOD) + (3 GOOD) + (2 SATISFACTORY) + (1 NEEDS IMPROVEMENT)	263	262	259	263	258
Indirect attainment in Percent	92.29	91.93	90.88	92.29	90.53
Attainment level through Indirect Attainment	3	3	3	3	3

In-Direct CO Attainment					
Assessment Tool	CO1	CO2	CO3	CO4	CO5
Course Exit Feedback on Cos	3	3	3	3	3
Overall Attainment Level	3	3	3	3	3
Average CO Attainment Level					3



COURSE INSTRUCTOR



HOD

H.O.D. - Computer Science & Engineering
A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY
Mangaluru - 575 006, D.K., Karnataka




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A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Computer Science and Engineering

Course Title:	AUTOMATA THEORY AND COMPUTABILITY	Academic Year:	2022-23													
Course Code:	18CS54	Course Instructor:	Mrs.Vidya Myageri													
Semester:	5	Course Index	C304													

CO-PO/PSO MAPPING

CoS	Cognitive Level	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C304.1	1,2,3	Acquire fundamental understanding of the core concepts in automata theory and Theory of Computation	2												2	
C304.2	1,2,3	Learn how to translate between different models of Computation (e.g., Deterministic and Non-deterministic and Software models).	2												2	2
C304.3	1,2,3	Design Grammars and Automata (recognizers) for different language classes and become knowledgeable about restricted models of Computation (Regular, Context Free) and their relative powers.	2				1								2	1
C304.4	1,2,3	Develop skills in formal reasoning and reduction of a problem to a formal model, with an emphasis on semantic precision and conciseness.	2													2
C304.5	1,2,3	Classify a problem with respect to different models of Computation.	2												2	
Target(AVG)			2	-	-	-	1	-	-	-	-	-	-	-	2	1.5

SELECT THE COMPLEXITY LEVEL OF THE COURSE **MODERATE**

OVERALL CO's Attainment					
Assessment Tool	CO1	CO2	CO3	CO4	CO5
Direct Attainment Level	3	3	3	3	3
In-Direct Attainment Level	3	3	3	3	3
Overall Attainment Level (70% of Direct Attainment Level + 30% of In-Direct Level)	3	3	3	3	3
Average CO Attainment Level					3

PO- PSO Attainment Through CO's (OVERALL Attainment Method)

Course Title	Course Index	Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Course Code	C504	18CS54	2	-	-	-	1	-	-	-	-	-	-	-	2	1.5


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NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING CONTENT DELIVERD IN REMEDIAL CLASS

Name of Course: Automata Theory and Computability Course Code:18CS54

Semester: V

Academic Year:2022-23

Name of Course Instructor: Mrs.Vidya Myageri

SL.NO	DATE	TOPIC DISCUSSED
1	9/12/2022	Deterministic FSM and Non-Deterministic FSM
2	16/12/202	Converting NDFSM to DFSM
3	6/01/2023	Regular Expression, Constructing RE from given FSM
4	13/01/202	Converting Regular Grammer to Regular expressions

Course Instructor

HOD

H.O.D. - Computer Science & Engineering
A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY
Mangaluru - 575 006, D.K., Karnataka

Principal

A.J. Institute of Engineering & Technology
Mangaluru - 575 006



AJ INSTITUTE OF ENGINEERING & TECHNOLOGY

A Unit of Laxmi Memorial Education Trust

(Approved by AICTE, New Delhi, Affiliated to Visvesvaraya Technological University, Belgaivi)

NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ATTENDANCE REPORT FOR REMEDIAL CLASS

Name of Course: Automata Theory and Computability Course Code:18CS54

Semester: V

Academic Year:2022-23

Name of Course Instructor: Mrs.Vidya Myageri

Sl No	USN	Name of the student	IA-1 Marks	9/12	16/12	IA-2 Marks	16/01	13/01
1	4JK20CS003	ADITHYAN K V	10	P	P	4	P	A
2	4JK20CS021	KARTHIK H R	11	P	P	9	P	P
3	4JK20CS024	MANORANJAN.M	16	P	P	-		
4	4JK20CS026	MOHAMMAD AMAN	18	P	P	-		
5	4JK20CS027	MOHAMMED	13	P	P	5	P	A
6	4JK20CS031	NISHAL S. P KARKERA	16	P	P	-		
7	4JK20CS053	VIDYASHREE SHETTY	10	P	P	-		
8	4JK20CS056	ZAID ALI AHAMAD	8	A	P	8	P	A
9	4JK21CS402	SUSHMA MALLESH KAIKAD	15	P	P	-		
10	4JK20CS004	ADVAITH PRASAD	-			7	P	P
11	4JK20CS005	AHMAD MIDLAJ B	-			10	P	P

Principal

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Mangaluru - 575006



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NH-66, Kottara Chowki, Mangaluru, Karnataka 575006

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

12	4JK20CS013	CLIVA RHEA MORAS	-			19	P	P
13	4JK20CS020	KARTHIK GANESH	-			18	P	P
14	4JK20CS039	RAHUL M MOOLYA	-			10	A	P
15	4JK20CS050	VAISHISHTA	-			17	P	P
16	4JK20CS055	YASHAS MANJAR	-			15	P	P
17	4JK21CS402	SUSHMA MALLESH KAIKAD	-			18	P	P

Course Instructor

HOD

H.O.D. - Computer Science & Engineering
A.J. INSTITUTE OF ENGINEERING AND TECHNOLOGY
Mangaluru - 575 006, D.K., Karnataka

Principal
A.J. Institute of Engineering & Technology
Mangaluru - 575 006

Name: Nedyo M

**A. J. Institute of Engineering and Technology
Mangaluru**

Sl. No.	USN	Name	No.:	1	2	3	4	5	6	7	8	9	10	11	12
				Date:	11/11	11/11	10/11	10/11	11/11	11/11	11/11	11/11	21/11	21/11	21/11
1	AJ520CS001	ABHJLASH. J. Y		1	2	3	4	5	A	6	7	8	A	9	10
2	002	ADARSH VIJOD		1	2	3	4	A	A	A	A	5	6	7	A
3	003	ADITHYAN. K. V		A	1	2	3	A	A	5	6	A	7	8	A
4	004	ADVAITH PRASAD		1	A	A	2	3	4	5	6	A	7	8	A
5	005	AHMAD MIDLAI. B		A	1	2	3	4	5	6	A	A	7	8	9
6	006	ALISHA. V		1	2	3	4	5	6	7	8	9	10	11	12
7	007	ANANYA. G. A		1	2	3	4	A	5	A	6	7	8	9	10
8	008	ANVITHA	A	A	1	2	3	A	4	5	6	7	8	9	10
9	009	ANVITHA		1	2	3	4	5	6	A	7	8	9	10	11
10	010	ASHWIN SHETTY		1	2	3	4	5	6	7	8	9	10	11	12
11	011	BHAGYASHREE		1	2	3	4	5	6	7	8	9	10	11	12
12	012	C. A. PRATNAL		A	1	2	3	4	5	6	7	8	A	9	10
13	013	CLIVA. RHEA. M		1	2	3	4	5	6	7	8	9	10	11	12
14	014	DEVI PRASAD RAJ. P		1	2	3	4	5	A	6	7	8	9	10	11
15	015	DHRUV KISHORE S		1	2	A	3	4	5	6	7	8	A	9	10
16	016	FARZEEN. HARI S		1	2	3	4	A	5	6	7	8	A	9	10
17	017	HRITHIK. G. K		1	2	3	4	5	6	7	8	9	10	11	12
18	018	ISHA SHEIKH. B		1	2	3	4	5	6	7	8	9	10	11	12
19	019	JEEVAN		1	2	3	4	A	5	6	7	8	9	10	11
20	020	KARTHIK. GAMESH		1	2	3	4	5	6	7	A	8	9	10	A
21	021	KARTHIK. H. R		1	2	3	4	5	6	7	8	9	10	11	12
22	022	LAKSHMI. V. K		1	2	3	4	5	6	7	A	8	9	10	11
23	023	MANNYA ANNA SAM		1	2	3	4	A	5	6	7	8	9	10	11
24	024	HANORANTAN. M		1	2	3	4	5	6	7	8	9	10	11	12
25	025	MANVITH. B. AMIN		1	2	3	4	5	6	7	8	9	10	11	12
26	026	MOHAMMAD. AMAN		1	2	3	4	5	6	7	8	9	A	A	10
27	027	MOHAMMED		1	A	2	3	A	A	5	6	7	A	A	8
28	028	N. R. NEERAJ		1	2	3	4	5	6	7	8	9	10	11	12
29	029	NAWRATHA. S		1	2	3	A	4	5	6	7	A	A	A	8
30	030	NEHA. V. P		1	2	3	4	5	6	7	8	9	10	11	12

**A. J. Institute of Engineering and Technology
Mangaluru**

13	14	15	16	17	18	19	20	21	22	23	24
11	12	13	14	15	16	17	18	19	20	21	22
8	9	10	11	12	13	14	15	16	17	18	19
9	10	A	11	12	13	14	15	16	17	A	18
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10	11	12	13	14	15	16	17	18	A	19	20
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11	12	13	14	15	16	17	18	19	A	A	20
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11	12	A	13	14	15	16	17	18	19	20	A
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13	14	15	16	17	18	19	20	21	22	23	24
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9	10	11	12	13	14	15	16	17	18	19	20
13	14	15	16	17	18	19	20	21	22	23	24
9	10	11	12	13	14	15	16	17	18	19	20
13	14	15	16	17	18	19	20	21	22	23	24
9	10	11	12	13	14	15	16	17	18	19	20
1											

Name: Aranya M

Sl. No.	USN	Name	No.:												
			1	2	3	4	5	6	7	8	9	10	11	12	
			Date:	3/11	11/11	10/11	16/11	17/11	14/11	21/11	22/11	22/11	22/11		
31	4JK20CS031	NITSHAL S.P		1	2	3	4	5	6	7	8	9	10	11	12
32	032	NIJSHANITH		1	A	1	2	3	4	5	6	7	8	9	A
33	033	POOJASHREE A.S		1	2	A	3	4	5	6	A	A	7	8	9
34	034	PRAKRUTHA S		1	2	3	4	5	6	A	7	8	9	9	10
35	035	PRAMYA		1	2	3	4	5	6	7	8	9	10	11	12
36	036	PRATEEK C.K		1	2	3	4	A	5	6	7	8	9	10	11
37	037	PRATHVJ D		1	2	3	4	A	5	6	7	8	9	10	11
38	038	RAHUL D.S		1	2	3	4	5	6	7	8	9	10	11	12
39	039	RAHUL M.M		1	2	3	4	5	6	7	8	9	10	11	12
40	040	RAMSHA R.AHMED		1	2	3	4	5	6	7	8	A	9	10	11
41	041	S.ATHREYA SHANMUK		1	2	3	4	5	6	7	8	9	10	11	12
42	042	SANNIDHI S.RAJ		1	2	3	4	5	6	7	8	9	10	11	12
43	044	SHARATH KUMAR		1	2	3	4	A	5	A	A	6	A	7	8
44	045	SHREYA S.SHETTY		1	2	3	4	5	6	7	8	9	A	10	11
45	046	SWASTHIS ACHAR		1	2	3	4	5	6	7	A	A	A	8	9
46	047	THEJASWI D.S		1	2	3	4	5	6	7	8	9	10	11	A
47	048	TRISHA R.RAJ		1	2	3	4	5	6	7	8	9	10	11	A
48	049	VAISHAK		1	2	3	4	5	6	7	8	9	10	11	12
49	050	& VAJSHISHTA		1	2	3	4	A	A	5	6	7	8	9	10
50	051	VARSHA B.S		1	2	3	4	5	6	7	A	8	9	10	11
51	052	VEENA B.R		1	2	3	4	5	6	7	8	9	10	11	12
52	053	VIDYASHREE S		1	2	3	4	5	6	7	A	8	9	10	A
53	054	VIJETH KUMAR		1	2	3	4	5	6	7	A	8	9	10	11
54	055	MASHAS M		1	2	3	A	4	5	6	7	8	9	10	11
55	056	ZADD ALI AHMED		1	2	3	4	5	6	7	8	9	10	A	11
56	4JK21CS400	MOUNA R.R		A	1	2	3	4	5	6	A	7	8	9	10
57	401	RAJANI A.P		1	2	3	4	5	6	7	8	9	10	11	12
58	402	SUSHMA MALLISH		A	1	2	3	A	4	A	A	5	6	7	8

Internal assessment																										
I		II		III		Average of (30)	CE (10)	Total I.A. Marks ()	Percentage of attendance																	
IA	%ATT.	IA	%ATT.	IA	%ATT.																					
13	14	15	16	17	18	19	20	21	22	23	24															
13	14	15	16	17	18	19	20	21	22	23	24															
10	11	12	13	14	15	A	16	17	18	A	19															
10	11	12	13	14	15	A	16	17	18	A	19															
11	12	13	14	15	16	17	18	19	A	20	21															
13	14	15	16	17	18	19	A	A	A	A	20															
12	13	14	15	16	17	A	18	19	20	A	21															
12	13	14	15	16	17	18	19	20	A	21	22															
13	14	15	16	17	18	19	20	21	22	23	24															
13	14	15	16	17	18	19	20	21	22	23	24															
12	13	14	15	16	17	18	19	20	A	21	22															
13	14	15	16	17	18	19	20	21	A	22	23															
13	14	15	16	17	A	A	18	19	A	20	21															
9	10	11	12	13	14	15	16	17	18	19																
12	13	14	15	16	17	18	19	20	A	21	22															
10	11	12	13	14	15	16	17	18	19	20	21															
A	12	13	14	15	16	17	18	19	A	20	21															
12	13	14	15	16	17	18	19	20	21	22	23															
13	14	15	16	17	18	19	20	21	22	23	24															
11	12	13	14	15	16	17	18	19	A	A	20															
12	13	14	15	16	17	18	19	20	A	21	22															
13	14	15	16	17	18	19	20	21	A	22	23															
11	12	13	14	15	16	17	18	19	A	A	20															
12	A	13	14	15	16	17	18	19	20	A	21															
12	13	14	15	16	17	18	19	20	21	22	23															
11	12	13	14	15	16	17	18	19	20	A	21															
13	14	15	16	17	18	19	20	21	A	22	23															
9	10	11	12	13	14	15	16	17	A	18	19															

Principal
A. J. Institute of Engineering & Technology
Mangaluru - 575 006

Internal assessment		Average of (30)	CE (10)	Total I.A. Marks ()	Percentage of attendance				
I						II		III	
IA	%ATT.	IA	%ATT.	IA	%ATT.				
16	73	28	80	22	88	14	10	24	100
49	82	50	80	50	88	30	10	40	89
39	82	39	80	33	83	20	10	30	85
27	92	35	92	50	85	23	8	33	87
39	100	43	84	50	90	27	10	37	91
44	92	27	88	32	88	21	10	31	89
41	92	41	92	48	88	26	10	36	89
22	100	21	100	16	88	12	10	22	88
26	91	10	76	12	88	10	10	20	87
28	100	23	51	34	83	17	10	27	85
42	100	34	96	44	85	24	10	34	87
27	100	29	88	24	85	16	10	26	87
45	92	45	92	41	90	27	10	37	91
28	92	35	92	34	93	20	10	30	94
38	73	22	88	36	85	20	10	30	87
49	100	45	88	50	88	29	10	39	89
39	100	31	96	30	90	20	10	30	91
32	100	24	100	40	93	20	10	30	94
20	82	17	84	36	88	15	10	25	89
47	92	33	92	50	88	26	10	36	89
37	100	29	96	36	85	21	10	31	87
10	100	26	92	35	80	15	10	25	85
25	92	29	88	40	85	19	10	29	87
33	82	34	80	48	85	23	10	33	88
8	73	8	84	29	90	9	10	19	89
25	73	19	76	29	85	15	10	25	88
50	100	45	96	50	98	29	10	39	98
15	64	18	80	30	85	13	10	23	87

Name: Aranya M

Sl. No.	USN	Name	N
31	4JK20CS031	ANISHAL S.P	
32	032	ALISHANITH	
33	033	POOJASHREE A.S	
34	034	PRAKRUTHJ.S	
35	035	PRAMYA	
36	036	PRATEEK.C.K	
37	037	PRATHVJ.D	
38	038	RAHUL.D.S	
39	039	RAHUL.M.M	
40	040	RAMSHA R.AHMED	
41	041	S.ATHREYA.SHANKAR	
42	042	SANJIVDHI.S.RAJ	
43	044	SHARATH.KUMAR	
44	045	SHREYA.S.SHETTY	
45	046	SWASTHIS.ACHAR	
46	047	THEJASWI.D.S	
47	048	TRESH.RAJ	
48	049	VAISHAB	
49	050	V.VAISHISHIA	
50	051	VARSHA.B.S	
51	052	VEENA.B.R	
52	053	VIDYASHREE.S	
53	054	VIJETH.KUMAR	
54	055	YASHAS.M	
55	056	ZABD.ALT.AHMED	
56	4JK20CS400	MOUNA.R.R	
57	401	RAJANA.P	
58	402	SUSHMA.MALLISH	

25	26	27	28	29	30	31	32	33	34	35	36
20/12	20/12	20/12	20/12	20/12	20/12	20/12	20/12	20/12	20/12	20/12	20/12
25	26	27	28	29	30	31	32	33	34	35	36
20	21	22	23	24	25	26	27	28	29	30	31
20	21	22	23	24	25	26	27	28	A	29	30
22	23	24	25	26	27	A	28	29	A	A	30
21	22	23	24	25	26	27	28	29	30	31	32
22	23	24	25	26	27	28	29	30	A	A	31
23	24	25	26	27	28	29	30	31	A	A	A
25	A	A	A	A	26	A	27	28	29	30	31
25	26	27	28	29	30	31	32	33	34	35	36
25	26	27	28	29	30	31	A	A	A	32	
25	26	A	A	A	27	A	28	29	A	A	30
22	23	24	25	26	27	28	29	30	A	A	A
20	21	22	23	24	25	26	27	28	29	30	31
23	24	25	26	27	28	A	29	30	31	32	33
22	A	A	23	24	25	26	27	28	29	30	A
22	23	24	25	26	27	28	29	30	31	32	A
25	A	A	25	26	27	28	29	30	31	A	32
25	26	27	A	A	28	A	29	30	31	32	33
21	22	23	24	25	26	27	28	29	30	A	31
23	A	A	24	25	26	27	28	29	30	31	A
25	A	A	A	A	26	26	27	28	29	A	30
21	22	23	24	25	26	27	28	29	30	A	31
22	23	24	25	26	27	A	28	29	A	A	30
22	23	24	25	26	27	A	28	29	30	A	31
25	25	26	A	27	28	29	30	31	32	33	34
22	23	24	25	26	27	A	28	29	30	31	32
24	25	26	27	28	29	30	31	32	33	34	35
20	21	22	23	24	25	26	27	28	29	30	A

37	38	39	40	41	42	43	44	45	46	47	48
20/12	20/12	20/12	20/12	20/12	20/12	20/12					
37	38	39	40	41	42	43					
37	38	39	40	41	42	43					
32	33	34	35	36	37	38					
A	31	32	33	34	35	36					
A	31	32	33	34	35	36					
33	34	35	36	37	38	39					
32	33	34	35	36	37	38					
32	33	34	35	36	37	38					
32	33	34	35	36	37	38					
32	33	34	35	36	37	38					
37	38	39	40	41	42	43					
33	34	35	A	A	A	36					
31	32	33	34	35	36	37					
31	32	33	34	35	36	37					
32	33	34	35	36	37	38					
34	35	36	37	38	39	40					
21	32	33	34	35	36	37					
A	33	34	35	36	37	38					
33	34	35	36	37	38	39					
34	35	36	37	38	39	40					
32	33	34	35	36	37	38					
32	33	34	35	36	37	38					
31	32	33	34	35	36	37					
32	33	A	A	34	35	36					
31	32	33	34	35	36	37					
32	33	34	35	36	37	38					
A	35	36	37	38	A	40					
33	34	35	26	A	A	27					
36	37	38	39	40	41	42					
31	32	33	34	35	36	37					

Principal

A. J. Institute of Engineering & Technology
Mangaluru - 575 006

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Subject: ATC

Sl. No.	Internal assessment						Average of (30)	CE (10)	Total I.A. Marks (40)	Percentage of attendance
	I		II		III					
	IA	%ATT.	IA	%ATT.	IA	%ATT.				
16	73	28	80	22	88	14	10	24	100	
49	82	50	80	50	88	30	10	40	89	
39	82	39	80	33	83	20	10	30	85	
27	91	35	92	50	85	23	8	33	87	
39	100	43	84	50	90	27	10	37	91	
44	91	27	88	32	88	23	10	31	89	
41	91	41	92	48	88	26	10	36	89	
22	100	21	100	16	88	12	10	22	88	
26	91	10	76	12	85	10	10	20	87	
28	100	23	51	34	83	17	10	27	85	
41	100	34	96	44	85	24	10	34	87	
27	100	29	88	24	85	16	10	26	87	
45	91	45	92	41	90	27	10	37	91	
28	91	35	92	34	93	20	10	30	94	
38	73	22	88	36	85	20	10	30	87	
49	100	45	88	50	88	29	10	39	89	
39	100	31	96	30	90	20	10	30	91	
32	100	24	100	40	93	20	10	30	94	
20	82	17	84	36	88	15	10	25	89	
47	91	33	92	50	88	26	10	36	89	
37	100	29	96	36	85	21	10	31	87	
10	100	26	92	35	80	15	10	25	85	
25	91	29	88	40	85	19	10	29	87	
33	82	34	80	48	85	23	10	33	88	
8	73	8	84	29	90	9	10	19	89	
25	73	19	76	29	85	15	10	25	88	
50	100	45	96	50	98	29	10	39	98	
15	64	18	80	30	85	13	10	23	87	

