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Note : Remove "Table of Content" before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

15CS54 : Automata Theory & Computability

A. COURSE INFORMATION

1. Course Overview

Degree:	B.E	Program:	CS
Semester :	V	Academic Year:	2018-19
Course Title:	Automata Theory & Computability	Course Code:	15CS54
Credit / L-T-P:	4-0-0	SEE Duration:	3 Hours
Total Contact Hours:	50	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	5
Course Plan Author:	Savita B Patil	Sign:	Dt:
Checked By:		Sign:	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
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 toOperational Systems, Simulators for FSMs, Minimizing FSMs, Canonical form of Regular languages, Finite State Transducers, Bidirectional Transducers.	10	Abstract State Machine Computational Models	L2,L4
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 Nonregular Languages: How many RLs, To show that a language is regular, Closure properties of RLs, to show some languages are not RLs	10	Pattern Language Rule Based System	L3,L4
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, Non-determinism and Halting, alternative equivalent definitions of a PDA, alternatives that are not equivalent to PDA.	10	Rule Based System Automata For CFG	L4
4	Context-Free and Non-Context-Free Languages: Where do the Context-Free Languages(CFL) fit, Showing a language is context-free, Pumping theorem for CFL, Important closure properties of CFLs, Deterministic CFLs. Algorithms and Decision Procedures for CFLs: Decidable questions, Un-decidable questions. Turing Machine: Turing machine model, Representation, Language acceptabilityby TM, design of TM, Techniques for TM construction.	10	Pumping Lemma Abstract Computer	L3,L4
5	Variants of Turing Machines (TM), The model of Linear Bounded automata: 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, Church-Turing	10	Multi Tape TM Linear Bounded Automata	L3

	thesis.			
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3. Course Material

Module	Details	Available
1	Text books:	
	1.. Elaine Rich, Automata, Computability and Complexity, 1st Edition, Pearson Education,2012/2013	In Lib
	2. K L P Mishra, N Chandrasekaran , 3rd Edition, Theory of Computer Science, PhI, 2012.	In Lib
2	Reference books	
	1. John E Hopcroft, Rajeev Motwani, Jeffery D Ullman, Introduction to AutomataTheory, Languages, and Computation, 3rd Edition, Pearson Education, 2013	In Lib
	2. Michael Sipser : Introduction to the Theory of Computation, 3rd edition, Cengage learning,2013	In Lib
	3. John C Martin, Introduction to Languages and The Theory of Computation, 3rd Edition,Tata McGraw –Hill Publishing Company Limited, 2013	In Lib
	4. Peter Linz, "An Introduction to Formal Languages and Automata", 3rd Edition, Narosa Publishers, 1998	In Lib
	5. Basavaraj S. Anami, Karibasappa K G, Formal Languages and Automata theory, Wiley India, 2012	In Lib
	6. C K Nagpal, Formal Languages and Automata Theory, Oxford University press, 2012.	In Lib
3	Others (Web, Video, Simulation, Notes etc.)	
	1.www.vtuplanet.com/download.php?type=papers...5%2FFLAT...Notes	Not Available
	2.vtu.allsyllabus.com/cse/sem_5/index.php	

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15Cs36	DMS	Set Theory	3		L3
	-					

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

#	Cos	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
15CS54.1	Understand the Core Concepts Of Automata Theory,Define the mathematical principles behind theoretical computer science.	2	Computational Model	Discussion	Assignment	L2 Understand

15CS54.2	Design,Translate, Differentiate Between Different abstract state machine(e.g:deterministic,Non-Deterministics),and give examples for the different types of automata	8	Abstract state machine	Problem solving	Slip test	L4 Analyze
15CS54.3	Build, convert Regular expression to Finite State machine to achieve pattern matching, to correlate the different types of automata to real world applications	5	Pattern Language	Lecture	Seminar	L3 Apply
15CS54.4	Construct, choose and design regular grammar to accept regular language, appropriate automata for the different requirements outlined by theoretical computer science.	5	Rule based system	Problem solving	Assignment	L4 Analyze
15CS54.5	Design ,simplify and Analyze context free grammar for context free languages & explain the application of machine models and descriptors to compiler theory and parsing	5	Rule based system	Problem solving	Slip test	L4 Analyze
15CS54.6	Analyze,construct Push down automata to accept context free grammar.	5	Automata for context free grammar	Discussion Problem solving	Viva Assignment	L4 Analyze
15CS54.7	Prove some languages are not context free languages using pumping lemma.	2	Pumping lemma	Lecture	Seminar	L3 Apply
15CS54.8	Analyze ,design turing machine .	8	Abstract machine	Discussion Problem solving	Viva Assignment	L4 Analyze
15CS54.9	Understand multitape turing machine to identify the different computational problems and their associated complexity.	2	Multitape turing machine	Lecture	Assignment	L2 Understand
15CS54.10	Understand Linear bounded automata	8	State machine	Discussion Problem solving	Viva Assignment	L3 Apply
-	**Total**	**50**	-	-	-	-

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level
1	Acquire fundamental Understanding of the core concepts of automata theory.	CO1	L2
2	commonly used to build software applications with finite state machines: Automata-based programming.	CO2	L4
3	Regular expressions are useful in a wide variety of text processing tasks,simple parsing, useful on Internet search engines.	CO3	L3
4	Design Grammar and Automata for different language classes and become knowledgeable about restricted models of computation.	CO4	L4
5	Used to describe the structure of programming languages,In most programming languages opening and closing of braces, curly brackets is taken care	CO5	L4
6	Online transaction process system , Deterministic top down parsing .	CO6	L4
7	Develop skills in formal reasoning and reduction of a problem to a formal model.	CO7	L3
8	Any computation that can be carried out by a mechanical means can be performed	CO8	L4

	by some Turing machine		
9	Genetic programming ,parse tree.	CO9	L2
10	Classify a problem with respect to different models of computation.	CO10	L3

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes		Program Outcomes												
#	COs	Course attainment	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Level
15CS54.1	Understand the Core Concepts Of Automata Theory,Define the mathematical principles behind theoretical computer science.	1	1	1	1	1			1	1	1			1	L2
15CS54.2	Design,Translate, Differentiate Between Different abstract state machine(e.g:deterministic,Non-Deterministics),and give examples for the different types of automata	2	2	2	2	2		2			2			2	L4
15CS54.3	Build, convert Regular expression to Finite State machine to achieve pattern matching, to correlate the different types of automata to real world applications	2	2	2	2	2					2			2	L3
15CS54.4	Construct, choose and design regular grammar to accept regular language, appropriate automata for the different requirements outlined by theoretical computer science.	2	2	2	2	2		2			2			2	L4
15CS54.5	Design ,simplify and Analyze context free grammar for context free languages & explain the application of machine models and descriptors to compiler theory and parsing	2	2	2	2	2		2	2		2			2	L4
15CS54.6	Analyze,construct Push down automata to accept context free grammar.	2	2	2	2	2		2	2		2			2	L4
15CS54.7	Prove some languages are not context free languages using pumping lemma.	2	2	2	2	2		2			2			2	L3
15CS54.8	Analyze ,design turing machine .	2	2	2	2	2		2	2		2			2	L4
15CS54.9	Understand,Analyze multitape turing machine to identify the different computational problems and their associated complexity.	1	1	1	1	1		1	1		1			1	L2

15CS54.10	Understand Linear bounded automata	2	2	2	2	2		2	2		2			2	L3
			10	10	01	10	-	8	6	1	10	-	-	10	
CS501PC.	Average	**1.8**	1.8	1.8	1.8	1.8	-	1.8	1.6	1	**1.8**	**-**	**-**	**1.8**	
	Note: Mention the mapping strength as 1, 2, or 3														

(CO – PO MAPPING)

-	Course Outcomes			Program Outcomes												
#	COs	Hours	Course attainment	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Level
15CS54.1	Understand the Core Concepts Of Automata Theory,Define the mathematical principles behind theoretical computer science.	2	2	2	2	2	2			2	2	2			2	L2
15CS54.2	Design,Translate, Differentiate Between Different abstract state machine(e.g:deterministic,Non-Deterministics),and give examples for the different types of automata	8	8	8	8	8	8		8			8			8	L4
15CS54.3	Build, convert Regular expression to Finite State machine to achieve pattern matching, to correlate the different types of automata to real world applications	5	5	5	5	5	5					5			5	L3
15CS54.4	Construct, choose and design regular grammar to accept regular language, appropriate automata for the different requirements outlined by theoretical computer science.	5	5	5	5	5	5		5			5			5	L4
15CS54.5	Design ,simplify and Analyze context free grammar for context free languages & explain the application of machine models and descriptors to compiler theory and parsing	5	5	5	5	5	5		5	5		5			5	L4
15CS54.6	Analyze,construct Push down automata to accept context free grammar.	5	5	5	5	5	5		5	5		5			5	L4
15CS54.7	Prove some languages are not context free languages using pumping lemma.	2	2	2	2	2	2		2			2			2	L3

15CS54.8	Analyze ,design turing machine .	8	8	8	8	8	8		8	8		8			8	L4
15CS54.9	Understand,Analyze multitape turing machine to identify the different computational problems and their associated complexity.	2	2	2	2	2	2		2	2		2			2	L2
15CS54.10	Understand Linear bounded automata	8	8	8	8	8	8		8	8		8			8	L3
				10	10	10	10	-	8	6	1	10	-	-	10	
	Sum hours		50	50	50	50	50	-	43	30	2	50	-	-	50	
CS501PC.	% hours		**100**	100	100	100	100	-	86	60	5	100	**-**	**-**	100	
	Level		**3**	3	3	3	3	-	3	3	1	3	**-**	**-**	3	
		Note: Mention the mapping strength as 1, 2, or 3														

parameter	BL	Hrs	co-A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Hrs	L2-L4	5	**3**	3	3	3	3	-	3	3	1	3	**-**	**-**	3
Level	L2-L4	5	**1.8**	1.8	1.8	1.8	1.8	-	1.8	1.6	1	**1.8**	**-**	**-**	**1.8**
course-Avg	**L2-L4**	**5**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**		**2.4**	**2.3**	**1**	**2.4**			**2.4**

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**	**-**	**-**
CO1	PO1	The knowledge of mathematical principles will help the students to apply the same to formulate solutions for engineering problems.like designing compilers,natural language processing,AI	L1
CO1	PO2	The knowledge of mathematical principles and automata theory will help the students to apply the same to identify and analyze engineering problems. Like how efficiently problems can be solved on a model of computation.to which extent a problem is solvable on a computer.	L1
CO1	PO3	Thorough understanding mathematical principles and automata theory students can give solution to complex engineering problems which may be helpful in health ,safety & societal considerations. Like vending machines,elevators,traffic lights.	
CO1	PO4	Thorough understanding automata theory they can conduct investigation of complex problems can be solved on the computer. like medical diagnosis ,robot control,remote sensing .	
CO1	PO5	No tool is used so no mapping.	
CO1	PO6	By understanding mathematical principles and automata theory students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in	

		health ,safety & societal considerations. Like It is used for Artificial Intelligence as part of making machines more intelligent, to understand better the languages and be more efficient & Artificial Intelligence is widely used in healthcare,Entertainment,finance etc.	
CO1	PO7	Thorough understanding automata theory they can know the environmental contexts.	
CO1	PO8	No ethical principles no mapping.	
CO1	PO9	Student will develop individual knowledge to work in a team or individually.	
CO1	PO10	No soft skills no mapping.	
CO1	PO11	No management principles no mapping.	
CO1	PO12	Study of automata theory is required if students want to work in system based companies.	
CO2	PO1	The study of finite state machines gives students to think in a logical way and will able able to apply the knowledge in complex engineering problems like AI	
CO2	PO2	Understanding of different automata will help to review and analyze engineering problems.	L2
CO2	PO3	Thorough understanding of different types of automata will help in the design and development of abstract models for computational problems. Like natural language processing,AI	L4
CO2	PO4	Study of automata with examples will help in conducting detailed investigation of complex engineering problems. Like whether efficient solution can be obtained or not.	L4
CO2	PO5	No tool is used so no mapping.	
CO2	PO6	By understanding finite state machines students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations.	
CO2	PO7	Not contains environmental context so no mapping.	
CO2	PO8	No ethical principles no mapping.	
CO2	PO9	Student will develop individual knowledge to work in a team or individually.	
CO2	PO10	No soft skills no mapping.	
CO2	PO11	No management principles no mapping.	
CO2	PO12	Study of automata theory is required if students want to work in system based companies.	
CO3	PO1	The knowledge of regular expressions will help the students to apply the same to formulate solutions for engineering problems.like search engines,string processing ,natural language processing,AI	
CO3	PO2	Correlating the study of automata to real world applications will aid in formulating engineering problems with similar background and arriving at with solutions like data validation, data scraping (especially web scraping), data wrangling,	
CO3	PO3	The real world application study of RE will help to design and develop solutions of similar kind engineering problems Like Regular expressions are used in web programming and in other pattern matching situations	
CO3	PO4	Study of Regular expressions with examples will help in conducting detailed investigation of complex engineering problems. Like lexical parsers for programming languages can be expressed and implemented using regular expressions	
CO3	PO5	No tool is used so no mapping.	
CO3	PO6	Not helpful in health ,safety & societal considerations so no mapping.	
CO3	PO7	Not contains environmental context so no mapping.	

CO3	PO8	No ethical principles no mapping.	
CO3	PO9	Student will develop individual knowledge to work in a team or individually.	
CO3	PO10	No soft skills no mapping.	
CO3	PO11	No management principles no mapping.	
CO3	PO12	Study of regular expression is required if students want to work in system as well as software based companies.for example if they want to build new search engine.	
CO4	PO1	The knowledge of regular grammar will help the students to apply the same to formulate solutions for engineering problems.Like natural language processing,AI.	
CO4	PO2	Detailed analytical and evaluative study of automata with help in identification, formulation and finding feasible solutions for real world computational problems.	
CO4	PO3	An evaluative knowledge of automata will help in applying the same while designing and developing solutions to computational problems.	
CO4	PO4	Evaluative learning of different type of automata will help in analysis and synthesis of real time computational problems.	
CO4	PO5	No tool content so no mapping	
CO4	PO6	By understanding regular grammar students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations for example Neural networks, Multi functional Radar construction.	
CO4	PO7	Not contains environmental context so no mapping.	
CO4	PO8	No ethical principles no mapping.	
CO4	PO9	Student will develop individual knowledge to work in a team or individually.	
CO4	PO10	No soft skills no mapping.	
CO4	PO11	No management principles no mapping.	
CO4	PO12	Study of automata theory is required if students want to work in system based companies.	
CO5	PO1	Understanding the different categories of basic computational problems will aid in applying the knowledge to find solutions of complex problems like CFG parsing for high speed network applications,Natural language processing.	
CO5	PO2	Different computational problems can be identified, formulated, reviewed and conclusions can be reached, when we are aware of the basic computational problems like Natural language processing, Human activities recognition.	
CO5	PO3	Complexity study of the basic computational problems will help in design and development of solutions for real time computational problems. For example Human activities recognition, Neural networks.	
CO5	PO4	Study of CFG with examples will help in conducting detailed investigation of complex engineering problems.For example Human activities recognition, Neural networks, Multi functional Radar construction.	
CO5	PO5	No tool content so no mapping	
CO5	PO6	By understanding CFG students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations. Like It is used for Artificial Intelligence as part of making machines more intelligent, to understand better the languages and be more efficient & Artificial Intelligence is widely used in healthcare,Entertainment,finance etc, Data processing.	

CO5	PO7	Thorough understanding CFG theory they can know the environmental contexts for example Human behavior recognition using a context-free grammar.	
CO5	PO8	No ethical principles no mapping.	
CO5	PO9	Student will develop individual knowledge to work in a team or individually.	
CO5	PO10	No soft skills no mapping.	
CO5	PO11	No management principles no mapping.	
CO5	PO12	Study of CFG is required if students want to work in system as well as software based companies. For example if they want to build Human behavior recognition using a context-free grammar is still a challenging problem due to many reasons, including limited accuracy of the data acquired by sensing devices.	
CO6	PO1	Understanding the different categories of basic computational problems will aid in applying the knowledge to find solutions of complex problems like CFG parsing for high speed network applications,Natural language processing.	
CO6	PO2	Understanding of different automata will help to review and analyze engineering problems.	
CO6	PO3	Thorough understanding of different types of automata will help in the design and development of abstract models for computational problems.	
CO6	PO4	Study of automata with examples will help in conducting detailed investigation of complex engineering problems.	
CO6	PO5	No tool content so no mapping.	
CO6	PO6	By understanding CFG students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations. Like It is used for Artificial Intelligence as part of making machines more intelligent, to understand better the languages and be more efficient & Artificial Intelligence is widely used in healthcare,Entertainment,finance etc, Data processing.	
CO6	PO7	Thorough understanding CFG theory they can know the environmental contexts for example Human behavior recognition using a context-free grammar.	
CO6	PO8	No ethical principles no mapping.	
CO6	PO9	Student will develop individual knowledge to work in a team or individually.	
CO6	PO10	No soft skills no mapping.	
CO6	PO11	No management principles no mapping.	
CO6	PO12	Study of PDA is required if students want to work in system as well as software based companies. For example if they want to build Human behavior recognition using a context-free grammar is still a challenging problem due to many reasons, including limited accuracy of the data acquired by sensing devices.	
CO7	PO1	The knowledge of pumping lemma will help the students to apply the same to formulate solutions for engineering problems.Like natural language processing,AI.	
CO7	PO2	Detailed analytical and evaluative study of automata with help in identification, formulation and finding feasible solutions for real world computational problems.	
CO7	PO3	An evaluative knowledge of automata will help in applying the same while designing and developing solutions to computational problems.	
CO7	PO4	Evaluative learning of different type of automata will help in analysis and synthesis of real time computational problems.	

CO7	PO5	No tool content so no mapping.	
CO7	PO6	By understanding pumping lemma students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations for example Neural networks, Multi functional Radar construction.	
CO7	PO7	No environmental context so no mapping.	
CO7	PO8	No ethical principles no mapping.	
CO7	PO9	Student will develop individual knowledge to work in a team or individually.	
CO7	PO10	No soft skills no mapping.	
CO7	PO11	No management principles no mapping.	
CO7	PO12	Study of automata theory is required if students want to work in system based companies.	
CO8	PO1	Understanding the different categories of basic computational problems will aid in applying the knowledge to find solutions of complex problems	
CO8	PO2	The knowledge of mathematical principles and turing machine will help the students to apply the same to identify and analyze engineering problems. Like how efficiently problems can be solved on a model of computation. To which extent a problem is solvable on a computer.	
CO8	PO3	Complexity study of the basic computational problems will help in design and development of solutions for real time computational problems	
CO8	PO4	Study of computational problems and their associated complexity will help to provide valid conclusions of real time computational problems	
CO8	PO5	No tool content so no mapping.	
CO8	PO6	By understanding turing machine students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations. Like It is used for Artificial Intelligence as part of making machines more intelligent, to understand better the languages and be more efficient & Artificial Intelligence is widely used in health care,Entertainment,finance etc, Data processing.	
CO8	PO7	Thorough understanding turing machine theory they can know the environmental contexts for example Human behavior recognition using a context-free grammar.	
CO8	PO8	No ethical principles no mapping.	
CO8	PO9	Student will develop individual knowledge to work in a team or individually.	
CO8	PO10	No soft skills no mapping.	
CO8	PO11	No management principles no mapping.	
CO8	PO12	Study of turing machine is required if students want to work in system as well as software based companies. For example if they want to build Human behavior recognition using a context-free grammar is still a challenging problem due to many reasons, including limited accuracy of the data acquired by sensing devices.	
CO9	PO1	Understanding the different categories of basic computational problems will aid in applying the knowledge to find solutions of complex problems	
CO9	PO2	Different computational problems can be identified, formulated, reviewed and conclusions can be reached, when we are aware of the basic computational problems	
CO9	PO3	Complexity study of the basic computational problems will help in design and development of solutions for real time computational	

		problems	
CO9	PO4	Study of computational problems and their associated complexity will help to provide valid conclusions of real time computational problems	
CO9	PO5	No tool content so no mapping.	
CO9	PO6	By understanding turing machine students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations. Like It is used for Artificial Intelligence as part of making machines more intelligent, to understand better the languages and be more efficient & Artificial Intelligence is widely used in health care,Entertainment,finance etc, Data processing.	
CO9	PO7	Thorough understanding turing machine theory they can know the environmental contexts for example Human behavior recognition using a context-free grammar.	
CO9	PO8	No ethical principles no mapping.	
CO9	PO9	Student will develop individual knowledge to work in a team or individually.	
CO9	PO10	No soft skills no mapping.	
CO9	PO11	No management principles no mapping.	
CO9	PO12	Study of turing machine is required if students want to work in system as well as software based companies. For example if they want to build Human behavior recognition using a context-free grammar is still a challenging problem due to many reasons, including limited accuracy of the data acquired by sensing devices.	
CO10	PO1	The knowledge of mathematical principles will help the students to apply the same to formulate solutions for engineering problems.like designing compilers,natural language processing,AI	
CO10	PO2	Understanding of different automata will help to review and analyze engineering problems.	
CO10	PO3	Complexity study of the basic computational problems will help in design and development of solutions for real time computational problems	
CO10	PO4	Thorough understanding of different types of automata will help in the design and development of abstract models for computational problems.	
CO10	PO5	No tool content so no mapping.	
CO10	PO6	By understanding linear bound automata students can apply contextual knowledge to assess solution to complex engineering problems which may be helpful in health ,safety & societal considerations for example Neural networks, Multi functional Radar construction.	
CO10	PO7	No environmental context so no mapping.	
CO10	PO8	No ethical principles no mapping.	
CO10	PO9	Student will develop individual knowledge to work in a team or individually.	
CO10	PO10	No soft skills no mapping.	
CO10	PO11	No management principles no mapping.	
CO10	PO12	Study of automata theory is required if students want to work in system based companies.	

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					

2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Introduction to the concept of automata theory & Finite state Machine.	10	2	-	-	1	1	2	CO1, CO2	L2,L4
2	Regular expressions & Regular grammar,Regular Language	10	2	-	-	1	1	2	CO3, CO4	L3, L4
3	Context free grammar & Push down automata	10	-	2	-	1	1	2	CO5, CO6	L4, L4
4	Context free languages & Turing machine	10	-	2	2	1	1	2	CO7, Co8	L3, L4
5	Multi tape turing machine & Linear bounded automata.	10	-	-	2	1	1	2	CO9, CO10	L2, L3
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2, CO3, CO4	L2,L4,L3,L4
CIA Exam – 2	15	CO5, CO6, CO7, Co8	L4,L4,L3,L4
CIA Exam – 3	15	CO9, CO10	L3,L2,L3

Assignment - 1	05	CO1, CO2, CO3, CO4	L2,L4,L3,L4
Assignment - 2	05	CO5, CO6, CO7, CO8	L4,L4,L3,L4
Assignment - 3	05	CO9, CO10	L3,L2,L3
Seminar - 1			
Seminar - 2			
Seminar - 3			
Other Activities – define – Slip test		CO1 to Co9	L2, L3, L4 . ..
Final CIA Marks	**20**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	ntroduction to the concept of automata theory Finite state machine.	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the Core Concepts Of Automata Theory.	CO1	L2
2	Design ,Translate Between Different abstract state machine(e.g:deterministic,Non-Deterministic)	CO2	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Why study the Theory of Computation, Languages and Strings: Strings,Languages.	Co1	L2
2	A Language Hierarchy, Computation, Finite State Machines(FSM): Deterministic FSM	CO2	L4
3	A Language Hierarchy, Computation, Finite State Machines(FSM): Deterministic FSM	CO2	L4
4	Regular languages, Designing FSM,Nondeterministic FSMs.	CO2	L4
5	Regular languages, Designing FSM,Nondeterministic FSMs.	CO2	L4
6	From FSMs to Operational Systems.	CO2	L4
7	Simulators for FSMs.	CO2	L4
8	Minimizing FSMs.	CO2	L4
9	Canonical form of Regular languages.	CO2	L4
10	Finite State Transducers, Bidirectional Transducers.	CO2	L4
c	**Application Areas**	**CO**	**Level**
1	Acquire fundamental Understanding of the core concepts of automata theory.	CO1	L2
2	commonly used to build software applications with finite state machines: Automata-based programming.	CO2	L4
d	**Review Questions**	-	-
1	What is the use of studying Theory of Computation?	CO1	L2
2	With example define i) String ii) Alphabet ii) Length of string iii) Concatenation of strings iv) string reversal v) prefix and vi) suffix	CO1	L2

3	Define Languages and Functions over languages	CO1	L2
4	Define DFSM an Regular language with example.	CO1	L2
5	Explain the difference between DFSM and NDFSM.	CO2	L4
6	Build a deterministic FSM for each of the following languages. List a string belonging to the L and a string not belonging to L. Give the configurations for the strings listed. a) L = {w ∈ {a, b}* : every a in w is immediately preceded & followed by b} b) L = {w ∈ {a, b}* : w does not end in ba }. c) L = {w ∈ {a, b}* : w has bbab as a substring}. d) L = {w ∈ {a, b}* : w has neither ab nor bb as a substring}. e) L = {w ∈ {0, 1}* : w is of even length and begins with 01}. f) L = {w ∈ {0, 1}* : strings such that number of 1's is even and the number of 0's is a multiple of 3 }	CO2	L4
7	Build a deterministic FSM for each of the following languages. a) L = {w ∈ {0, 1}* : w corresponds to the binary encoding, without leading 0's, of natural numbers that are evenly divisible by 4}. b) L = {w ∈ {0, 1}* : w corresponds to the binary encoding, without leading 0's, of natural numbers that are powers of 4}. c) L = {w ∈ {0, 1}* : w has 001 as a substring}. d) L = {w ∈ {0, 1}* : w does not have 001 as a substring}. e) L = {w ∈ {a, b}* : w contains at least two b's that are not immediately followed by a's}. f) The set of binary strings with at most one pair of consecutive 0's and at most one pair of consecutive 1's. g) L = {w ∈ {a, b}* : |w| ≡ 5 0 } h)L = {w ∈ {a, b}* : |w| mod 3 = 0 } i)L = {w ∈ {a, b}* : In w, 4th character from last is a } j)L = {w ∈ {a, b}* : w is not ending with abb }. k)L = {w ∈ {a, b}* : all strings with at least one 'a' and exactly two 'b's} l)L = {w ∈ {a-z}* : all five vowels occur in w in alphabetical order } m)L = {w ∈ {a, b}* : w has both aa and bb as a substrings}. n)L = {(01) i 2 j | i≥1, j≥1} o)L = {w ∈ {0,1}* : strings represented in binary, that are divisible by 4 p)L = {w ∈ {0-9}* : strings represented in decimal, that are divisible by 3	CO2	L4
8	Define NDFSM with example.	CO1	L2
9	Give the difference between DFSM and FSM	CO2	L4
10	Design Non-Deterministic FSM for the following languages a) L = {w ∈ {a - z}* : all five vowels a, e, i o, and u occur in w in alphabetical order} 5 b) L = {w ⌆ {a, b}* : w is made up of an optional a followed by aa followed by zero or more b's}. c) L = {w ⌆ {a, b}* : w = aba or |w| is even}. d) L = {w ⌆ {a, b, c}* : ‸x, y ⌆ {a, b, c}* (w = x abcabb y)}. e) L = {w ⌆ {a, b}* : the fourth to the last character is a} f) Σ={a, b, c, d}, L = { w : there is a symbol a 1 ⌆ Σ not appearing in w}	CO2	L4
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

Module – 2

Title:	Regular expressions & Regular grammar,Regular Language	Appr	10 Hrs

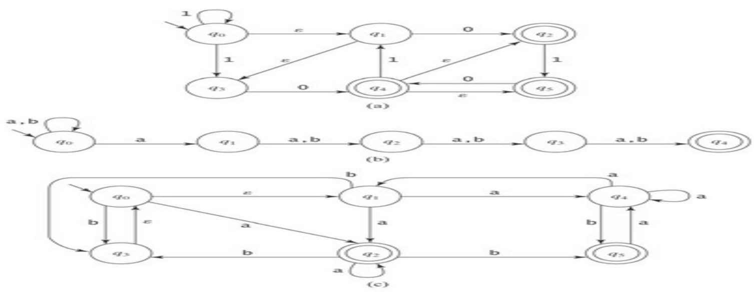
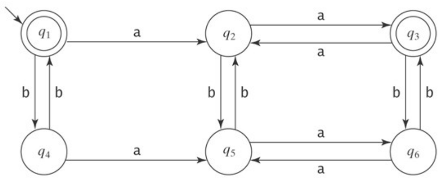
		Time:	
a	***Course Outcomes***	-	**Blooms**
-		-	**Level**
1	Build, convert Regular expression to Finite State machine using kleen's theorem to achieve pattern matching	CO3	L3
2	Construct regular grammar to accept regular language.	CO4	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
11	Regular Expressions (RE): what is a RE?, Kleene's theorem	CO3	L2
12	Applications of REs.	CO3	L2
13	Manipulating and Simplifying REs	CO3	L3
14	Regular Grammars: Definition,Regular Grammars and Regular languages	CO4	L3
15	Regular Languages (RL) and Nonregular Languages: How many RLs,	CO4	L4
16	Regular Languages (RL) and Nonregular Languages: How many RLs,	CO4	L2
17	To show that a language is regular	CO4	L4
18	Closure properties of RLs	CO4	L3
19	To show some languages are not RLs	CO4	L4
20	To show some languages are not RLs	CO4	L4
c	**Application Areas**	**CO**	**Level**
1	Regular expressions are useful in a wide variety of text processing tasks,simple parsing, useful on Internet search engines.	CO3	L3
2	Design Grammar and Automata for different language classes and become knowledgeable about restricted models of computation.	CO4	L4
d	**Review Questions**	-	-
12	Write R.E for the following language 1)L={$a^{2n}b^{2m}$|n>=0,m>=0} 2)L={w:|w|mod3=0 where w Ɛ (a,b)*} 3)L={u v u: u,v Ɛ (a,b)* & |v|=2}	CO3	L1
13	Construct an fsm for the following Regular Expression 1)(b+ab)* 2)a*+b*+c*	CO4	L3
14	State and prove pumping lemma for non regular languages	CO3	L2
15	Show a regular language for each of the following languages 1)L={w Ɛ {a,b}*:w contains the substring abb} 2)L={w Ɛ {a,b}*:w does not end in aa}	CO4	L4
16	Prove that regular languages are closed under difference,complement & intersection.	CO4	L2
17	Show that following languages are not regular 1)L={$a^n b^n$|n>=0} 2)L={ww^R|w Ɛ (0,1)*}	CO3	L4
18	Write algoritm fsmtoregexheuristic() and fsmtoregex() to obtain R.E from FSM	CO3	L2
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3

5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

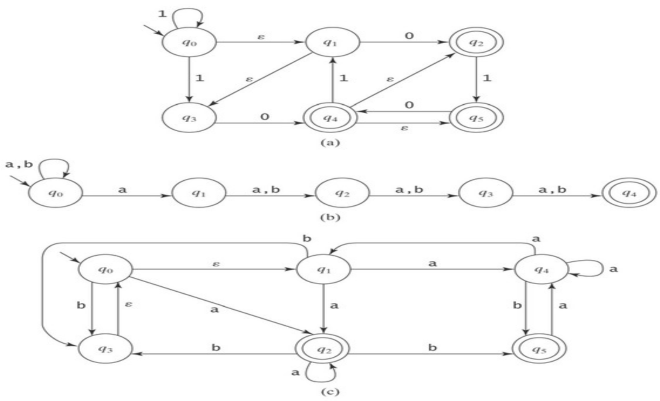
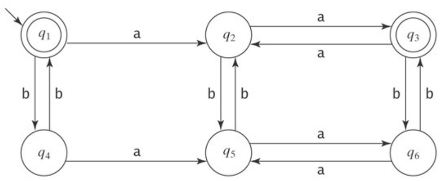
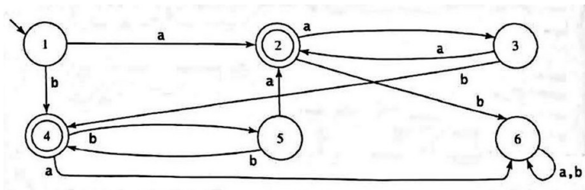
Crs Code:	15CS54	Sem:	V	Marks:	30	Time:	75 minutes
Course:	Automata Theory & Computability						

-	-	**Note: Answer any 3 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Define DFSM & NDFSM.Design DFSM for the following languages 1.L={Having even no.of a's and even no.of b's}	5	CO1	L1,L4
	b	Design NDFSM for the following languages 1.L={w:wÎ$abab^n$ or aba^n where n>=0} 2.L={w is made up of an optional a followed by aa followed by zero or more b's}	5	CO2	L4
	c	Build a deterministic FSM for each of the following languages. a.L = {w ∈ {0, 1}* : w has 001 as a substring}. b) L = {w ∈ {0, 1}* : w does not have 001 as a substring}.	5	CO2	L4
2	a	Find the equivalence DFSM for the following NDFSM 	5	CO2	L4
	b	Prove that Iff the language L is accepted by NDFSM then there exists an equivalent DFSM.	5	CO2	L4
	c	Minimize the following DFSM 	5	CO2	L4
3	a	Write R.E for the following language 1)L={$a^{2n}b^{2m}$|n>=0,m>=0} 2)L={w:|w|mod3=0 where w Ɛ (a,b)*}	5	CO3	L4
	b	Write R.E for the following language L={u v u: u,v Ɛ (a,b)* & |v|=2}	5	CO3	L4
	c	Construct an fsm for the following Regular Expression 1)(b+ab)* 2)$a^*+b^*+c^*$	5	CO3	L4
4	a	State and prove pumping lemma for non regular languages	5	CO3	L2
	b	how a regular language for each of the following languages 1)L={w Ɛ {a,b}*:w contains the substring abb} 2)L={w Ɛ {a,b}*:w does not end in aa}	5	CO4	L4
	c	Show that following languages are not regular 1)L={an bn|n>=0} 2)L={wwR|w Ɛ (0,1)*	5	CO4	L4

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15CS54	Sem:	V	Marks:	5	Time:	90 – 120 minutes
Course:	Automata Theory & Computability						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Convert following NDFSMs to DFSM. Give the eps() states for all states. 	5	CO2	L4
2		Describe the algorithm to minimize DFSMs	5	CO1	L2
3		Minimize following DFSMs  	5	CO2	L4
4		Define finite state transducers.	5	CO2	L2
5		Explain Moore machine with example	5	CO2	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	Context free grammar & Push down automata	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Design ,simplify context free grammar for context free languages	CO5	L4
2	Analyze,construct Push down automata to accept context free grammar.	CO6	L4

b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
21	Context-Free Grammars(CFG): Introduction to Rewrite Systems and Grammars	CO5	L2
22	CFGs and languages, designing CFGs	CO5	L4
23	simplifying CFGs, proving that a Grammar is correct	CO5	L4
24	Derivation and Parse trees	CO5	L4
25	Ambiguity	CO5	L4
26	Normal Forms	CO5	L4
27	Pushdown Automata (PDA): Definition of non-deterministic PDA, Deterministic and Non-deterministic PDAs	CO6	L2
28	Pushdown Automata (PDA): Definition of non-deterministic PDA, Deterministic and Non-deterministic PDAs	CO6	L4
29	Non-determinism and Halting, alternative equivalent definitions of a PDA	CO6	L4
30	Alternatives that are not equivalent to PDA.	CO6	L4
c	**Application Areas**	**CO**	**Level**
1	Used to describe the structure of programming languages,In most programming languages opening and closing of braces, curly brackets is taken care	CO5	L4
2	Online transaction process system , Deterministic top down parsing .	CO6	L4
d	**Review Questions**	-	-
1	Define the following with example. a. Rewrite system b. Context Free Grammar c. Recursive and self embedding grammar	CO5	L2
2	Write the CFG for following languages. a. L= {a n b n | n>=0 } b. L= {a 2n b n | n>=0 } c. L= {a n b 2n | n>=0 } d. L= {a 2n b n | n>=1 } e. L= {a n b 2n | n>=1 } f. L= {a n b n+1 | n>=0} g. L= {a n b n+2 | n>=0} h. L= {a n+3 b n | n>=1 } i. L= {a n+2 b n | n>=1} j. L = {a n b m : n ㄴㅎ m} k. L = {a n b m : n a (w)>n b (w)} l. L={ww R | w ε{a,b}*} m. L={0 m 1 m 2 n | m>=1, n>=0} n. L={0 i 1 j | i ㄴㅎ j, i>=0, j>=0} o. L = {a n b m : n>=0, m >n} p. L = {a n b n-3m : n>=3} q. L={w: |w|mod 3 ㄴㅎ |w|mod 2 on {a}} r. L={w: |w|mod 3 >= |w|mod 2 on {a}} s. L={a m b m c k | n+2m=k for n>=0, m>=0} t. No more than 3 a's on {a,b}	CO5	L4

	u. strings of 0's and 1's having substring '000' v. strings of a's and b's starting with 'a' and ending with 'b' w. strings of a's and b's whose length is multiple of 3. x. L = {a n b m : n a (w)>n b (w)+1		
3	Write the algorithm removeunproductive(G) and removeunreachable(G).	CO5	L3
4	Simplify the following grammars: a)S → aA |bB , A → aA |a , B → bB , D → ab|Ea , E → aC | d b)S → AB |AC , A → aA |bAa|a, B → bbA|aB|AB , C → aCa|aD , D → aD|bC	CO5	L4
5	Prove that Grammar for L = {a ^{n} b ^{n} : n >= 0}} is correct. R= { S-> aSb, S->€ }.	CO5	L4
6	Define the following a. Derivation b. Left-Most Derivation c. Right-Most Derivation d. Parse Tree	CO5	L2
7	Obtain Left most derivation (LMD) and Right most derivation (RMD) for the string +*-xyxy using the grammar E-> +EE |*EE|-EE|x|y	CO5	L4
8	Obtain LMD and RMD for id+id*id using 6	CO5	L4
9	Consider the CFG with productions E → E+T | T T → T*F |F F → (E) | 0 | 1 Write LMD, RMD and parse tree for the string 0+((1*0)+0) E → E+E|E*E|(E)|id	CO5	L4
10	Define the following a.Ambiguity b.Inherently ambiguous grammar c.Nullable variable d.Useless symbol	CO5	L2
11	Show that the following grammars are ambiguous. a) S → SbS |a b) S →iCtS |iCtSeS|a, C → b	C05	L4
12	Consider the grammar: S → aS |aSbS | ε Is the above grammar ambiguous? Show that the string "aab" has two - i) Parse trees ii) Left most derivations iii) Right most derivations	CO5	L4
13	List three structures in CFG that lead to ambiguity. How to overcome these problems?	CO5	L3
14	Remove ambiguity from following grammars. a) S → (S) | SS |ϵ b) E →E+E|E*E|(E)|id	CO5	L4
15	Define CNF and GNF.	CO5	L2
16	Convert each of the following grammars to Chomsky normal form. **a.** S → aSa S → B B → bbC B → bb C → ε C → cC **b.** S → ABC A → aC | D B → bB | ε | A C → Ac | ε | Cc D → aa **c.** S → aTVa T → aTa | bTb | ε | V V → cVc | ε	CO5	L4

17	Convert the following CFG to CNF. a. $S \rightarrow aB \mid bA$, $A \rightarrow a \mid aS \mid bAA$, $B \rightarrow b \mid aS \mid aBB$ b. $S \rightarrow AB \mid a$, $A \rightarrow aab$, $B \rightarrow Ac$ c. $S \rightarrow aBa \mid abba$, $A \rightarrow ab \mid AA$, $B \rightarrow aB \mid a$.	CO5	L4
18	Write an algorithm for a. removeEps( ) b. atmostoneEps( ) c. removeUnits( ) d. removeMixed(G) e. RemoveLong(G)	CO5	L3
19	Define a) PDA b) Deterministic PDA c) Computation in PDA d) String accept in PDA e) String reject in PDA	CO6	L2
20	Design PDA along with transition diagram for the following language: $L = \{a^n b^n \mid n >= 0\}$. Write the computation (sequence of all configurations) for the input string 'aabbb' and 'aabb'.	CO6	L4
21	Construct PDA for the following language with transition diagram. a. string of balanced parentheses. b. $L = \{a^n b^{2n} \mid n >= 1\}$ c. $L = \{ww^R \{w \; \varepsilon \{a,b\}^*\}$. d. $L = \{w \; \epsilon \{a, b\}^* : \#_a(w) = \#_b(w)\}$	CO6	L4
	Discuss the Techniques for reducing non-determinism with example.	CO6	L2
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

Module – 4

Title:	Context free languages & Turing machine	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Prove some languages are not context free languages using pumping lemma.	CO7	L3
2	Analyze ,design turing machine .	CO8	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
31	Context-Free and Non-Context-Free Languages: Where do the Context-Free Languages(CFL) fit	CO7	L2
32	Showing a language is context-free, Pumping theorem for CFL	CO7	L3
33	Important closure properties of CFLs, Deterministic CFLs.	CO7	L3
34	Algorithms and Decision Procedures for CFLs: Decidable question	CO7	L4
35	Un-decidable questions	CO7	L2
36	Turing Machine: Turing machine model, Representation, Language	CO8	L2

	acceptabilityby TM		
37	Turing Machine: Turing machine model, Representation, Language acceptabilityby TM	CO8	L4
38	Design of TM Techniques for TM construction	CO8	L4
39	Design of TM Techniques for TM construction	CO8	L4
40	Design of TM Techniques for TM construction	CO8	L4
c	**Application Areas**	**CO**	**Level**
1	Develop skills in formal reasoning and reduction of a problem to a formal model.	CO7	L3
2	Any computation that can be carried out by a mechanical means can be performed by some Turing machine	CO8	L4
d	**Review Questions**	-	-
1	Prove that context-free languages are closed under: • Union • Concatenation • Kleene star • Reverse	CO7	L3
2	Prove that CFL's are closed under intersection and difference with the Regular languages	CO7	L3
3	State and prove pumping theorem for context free languages.	CO7	L2
4	The Language of Strings with n 2 a's i.e. L = {a : n ≥ 0} is not CFL	CO7	L4
5	Prove that L = {a n b m a n : m, n ≥ 0, m≥n} is not context free.	CO7	L4
6	Prove L = {wcw, w is in $\{a,b\}^*$ } if not CFL	CO7	L4
7	Using the pumping theorem in conjunction with the closure properties proveWW = {ww, w ∈ $\{a, b\}^*$} is not context free	CO7	L4
8	Using the pumping theorem in conjunction with the closure Properties, a simple arithmetic language L = { x#y = z : x, y, z ∈ $\{0,1\}^*$ and if x, y, z are viewed as positive binary numbers without leading zeros, xy = z R } is not	CO7	L3
9	Prove that every deterministic CFL is context free. (It is assumed that the strings in L ends with $)	CO7	L3
10	Prove that every deterministic CFL's are closed under complement	CO7	L3
11	Prove that every deterministic CFL's are not closed under union and intersection .	CO7	L3
12	Write a note on hierarchy of CFL.	CO7	L2
13	Briefly explain representations of TM with example	CO8	L2
14	Design a Turing machine to recognize all strings consisting of an even number of 1's. Obtain the computation sequence for 11 and 111.	CO8	L4
15	Design a Turing machine over {1, b} which can compute a concatenation function over Σ = {1}. If a pair of words (w 1 , w 2) is the input, the output has to be w 1 w 2. Give the computation for 11b111	CO8	L4
16	Design TM that accepts $\{1^n 2^n 3^n \mid n \geq 1\}$. Write the ID's for 1223, 1123, 1233 and 112233.	CO8	L4
17	Briefly explain the following techniques of TM construction a. Turing Machine with Stationary Head b. Storage in the State c. Multiple Track Turing Machine d. Subroutines	CO8	L2
18	Design a TM which can multiply two positive integers	CO8	L4

e	Experiences	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15CS54	Sem:	V	Marks:	30	Time:	75 minutes
Course:	Automata Theory & Computability						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	Construct context-free-language for the following languages 1)let Σ=(a,b)* obtain a grammar G generating set of all palindromes. 2)L={ $0^m1^m2^n$|n>=0,m>=1} 3)L={ a^n b^m c^k|n+2m=k for m,n>=0}	5	CO5	L4
	b	Show that the grammar is ambiguous & obtain unambiguous grammar for the same S ->(S) , S -> SS , S ->Ɛ	5	CO5	L4
	c	Obtain PDA for the language L={a^n b^n| n>=1}	5	CO6	L4
			5		
2	a	Is the PDA deterministic L={wCw^R |w Ɛ (a,b)*}	5	CO6	L4
	b	Is the PDA deterministic L={$\#_a$(w) = $\#_b$(w) |w Ɛ (a,b)*}	5	CO6	L4
	c	Obtain the PDA for the following CFG using both TOP-DOWN and BOTTOM-UP parser E->E+T | T , T->T*F | F , F->(E) | id	5	CO6	L4
3	a	State and prove pumping lemma for CFL.	5	CO7	L3
	b	Show that the language L={$a^nb^nc^n$ | n>=1}is not CFL.	5	CO7	L3
	c	Prove that every deterministic CFL's are closed under complement		CO7	L4
4	a	Briefly explain representations of TM with example	5	CO8	L3
	b	Construct an TM for the language={ $0^n1^n2^n$ | n>=1}	5	CO8	L4
	c	Design TM that accepts {1^n 2^n 3^n | n ≥ 1 }. Write the ID's for 1223, 1123, 1233 and 112233.	5	CO8	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15CS54	Sem:	v	Marks:	5	Time:	90 – 120 minutes
Course:	Automata Theory & Computability						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Write the CFG for following languages. a. L= {a n b n | n>=0 } b. L= {a 2n b n | n>=0 } c. L= {a n b 2n | n>=0 } d. L= {a 2n b n | n>=1 } e. L= {a n b 2n | n>=1 }	5	CO5	L4
2		Simplify the following grammars: a)S → aA |bB , A → aA |a , B → bB , D → ab|Ea , E → aC | d b)S → AB |AC , A → aA |bAa|a, B → bbA|aB|AB , C → aCa|aD , D → aD|bC	5	CO5	L4
3		Consider the grammar: S → aS |aSbS | ε Is the above grammar ambiguous?		CO5	L4

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		Show that the string “aab” has two - i) Parse trees ii) Left most derivations iii) Right most derivations			
4		Design a PDA for the following language: L = {wcw^R : w ε {a,b}*}. Also Draw the transition diagram. Write the computation (sequence of all configurations) for the input string 'abacaba' and ‘abcab’	5	CO6	L4
5		Prove that L = { $a^n b^n c^n$, n≥0} not context free	5	CO7	L3
6		Briefly explain Turing Machine model. Give its definition.	5	CO8	L2
7		Design TM that accepts {$0^n 1^n$ | n≥ 1 }. Obtain the computation for 0011 and 010	5	CO8	L4
8		Prove that L = { a n b n c n , n≥0} not context free	5	CO8	L4
9		Prove that context-free languages are not closed under: • intersection • complement • difference	5	CO8	L3
10		Convert the following CFG to CNF. S → aACa A → B | a B → C | c C → Cc | ε	5	CO5	L4

D3. TEACHING PLAN - 3

Module – 5

Title:	Multi tape turing machine & Linear bounded automata.	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand multitape turing machine.	CO9	L2
2	Understand Linear bounded automata	CO10	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
41	Variants of Turing Machines (TM), The model of Linear Bounded automata: Decidability	CO9	L2
42	Definition of an algorithm, decidability, decidable languages	CO9	L2
43	Undecidable languages, halting problem of TM	CO9	L2
44	Post correspondence problem	CO10	L2
45	Complexity: Growth rate of functions	CO10	L3
46	The classes of P and NP	CO10	L2
47	Quantum Computation: quantum computers	CO10	L3
48	Quantum Computation: quantum computers	CO10	L2
49	Church-Turing thesis	CO10	L2
50	Church-Turing thesis	CO10	L2

c	**Application Areas**	**CO**	**Level**
1	Understand multitape turing machine.	CO9	L2
2	Understand Linear bounded automata	CO10	L3
d	**Review Questions**	-	-
1	Explain the following types of TM: a. Multitape TM b. Non deterministic TM	CO9	L2
2	Prove that every language accepted by a multi-tape TM is acceptable by some single-tape TM (that is, the standard TM).	CO9	L2
3	Prove that, if M 1 is the single-tape TM that simulates multitape TM M, then the time taken by M 1 to simulate n moves of M is O(n 2).	CO9	L3
4	Prove that, if M is a nondeterministic TM, there is a deterministic TM M 1 such that T(M) = T(M 1)	CO9	L3
5	Explain the model of Linear bounded Automata.	CO10	L2
6	Prove that a. A DFA is decidable. b. A CFG is decidable. c. A CSG is decidable.	CO10	L2
7	Prove HALT TM = {(M, w) |The Turing machine M halts on input w} is undecidable.	CO10	L3
e	**Experiences**	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15CS54	Sem:	V	Marks:	30	Time:	75 minutes
Course:	Automata Theory & Computability						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	Define : a. recursively enumerable language b. recursive language c. decidable languages d. undecidable languages	5	CO9	L2
	b	Write short notes on : a.Recursively Enumerable Language b.Post correspondence problem c.Languages of PDA	5	CO9	L2
	c	Define a turing machine.show that a multitape turing machine is euivalent to basic turing machine.	5	CO9	L2
2	a	Write short notes on Turing machine Halting problem.	5	CO9	L2
	b	Write short notes on Multitape TM.	5	CO9	L2
	c	Write short notes on Recursive language.	5	CO9	L2
3	a	Prove that a. A DFA is decidable.	5	CO10	L2

		b. A CFG is decidable. c. A CSG is decidable.			
	b	Prove HALT TM = {(M, w) |The Turing machine M halts on input w} is undecidable.	5	CO10	L3
	c	Prove that A TM is undecidable.	5	CO10	L3
4	a	Show that the union of two recursively enumerable languages is recursively enumerable and the union of two recursive languages is recursive.	5	CO10	L3
	b	State and explain Church-Turing Thesis.	5	CO10	L2
	c	Write a note on quantum computation.	5	CO10	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	CS501PC	Sem:	I	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Design and Analysis of Algorithms						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Write short notes on Turing machine Halting problem.	5	CO9	L2
2		Write short notes on Multitape TM.	5	CO9	L2
3		Show that the union of two recursively enumerable languages is recursively enumerable and the union of two recursive languages is recursive.	5	CO9	L2
4		a. Does the PCP with two lists x = (b, bab 3 , ba) and v = (b 3 , ba, a) have a solution?	5	CO10	L4
5		Prove that PCP with two lists x = (01, 1, 1), Y = (01 2 , 10, 1 1) has no solution.	5	CO10	L4
6		If L is a recursive language over Σ, show that $\overline{L}$ ($\overline{L}$ is defined as Σ* - L) is also recursive.		CO10	L4
7		If L and $\overline{L}$ are both recursively enumerable, show that L and $\overline{L}$ are recursive.	5	CO10	L3
8		Prove that the growth rate of any exponential function is greater than that of any polynomial.	5		
9		Prove that A TM is undecidable.	5	CO10	L4
10		Write a note on quantum computation.	5	CO10	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Automata Theory & Computability					Month / Year	May /2018
Crs Code:	15CS54	Sem:	V	Marks:	80	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Define i) Powers of an alphabet ii) N F A.	2	CO1	L2
	b	Design a DFA to accept the following language over the alphabet { 0, 1 }. i) L = {co I co is a even number} ii) L = {(01)' 1 23 I i 1, j 1} iii) The set of strings either start with 01 or end with 01.	6	CO2	L4
	c	Consider the following Ɛ— NFA. | | ε | a | b | c | | p | null | p | q | r |	8	CO2	L4

		q | p | q | r | null r | q | r | null | p			
		OR			
-	a	Mention the differences between DFA, NFA and E-NFA.	2	CO1	L2
	b	Design a DFA which accepts set of all strings of 0's and l's. beginning with a 1 that, when interpreted as a binary integer, is a multiple of 5. For example, strings 101, 1010 and 1111 are in the language; 0, 100, 0101 and 111 are not	6	CO2	L4
	c	convert the following NFA to DFA using subset construction method | 0 | 1 p | {p,q} | {p} q | null | {r} r | {p,r} | {q}	8	CO2	L4
2	a	Give the regular expressions for the following languages i)L = $\{a^n b^m : n <= 4, m>= 2\}$; ii) L = {w : W (0, 1)* and |w|mod 3 = 0}.	4	C03	L4
	b	Define CFG. Design a context free grammar for the languages: (i)_L = $\{a^i b^j c^k$, where i = j + k, i, j, k >=0}. ii) L = $\{0^{n+2}\ 1^n : n >=1\}$	4	CO4	L4
	c	What is an ambiguous grammar? Show that the grammar shown below is ambiguous on the string "aab". S —> AB/aaB A —> Aa/a B —>b.	8	CO4	L4
		OR			
-	a	Write R.E for the following language 1)L={$a^{2n}b^{2m}$|n>=0,m>=0} 2)L={w:|w|mod3=0 where w Ɛ (a,b)*}	4	CO3	L4
	b	how a regular language for each of the following languages 1)L={w Ɛ {a,b}*:w contains the substring abb} 2)L={w Ɛ {a,b}*:w does not end in aa}	8	CO4	L4
	c	Show that following languages are not regular 1)L={an bn|n>=0} 2)L={wwR|w Ɛ (0,1)*	4	CO4	L4
3	a	Construct context-free-language for the following languages 1)let Σ=(a,b)* obtain a grammar G generating set of all palindromes. 2)L={ $0^m 1^m 2^n$|n>=0,m>=1}	4	CO5	L4
	b	Show that the grammar is ambiguous & obtain unambiguous grammar for the same S ->(S) , S -> SS , S ->Ɛ	8	CO5	L4
	c	Obtain PDA for the language L={$a^n b^n$ | n>=1}	4	CO6	L4
		OR			
-	a	Remove ambiguity from following grammars. a) S → (S) | SS |ϵ b) E →E+E|E*E|(E)|id	6	CO5	L4
	b	Is the PDA deterministic L={wCw^R |w Ɛ (a,b)*}	4	CO6	L4
	c	Is the PDA deterministic L={$\#_a(w) = \#_b(w)$ |w Ɛ (a,b)*}	6	CO6	L4
4	a	State and prove pumping theorem for context free languages.	4	CO7	L2
	b	The Language of Strings with n 2 a's i.e. L = {a : n ≥ 0} is not CFL	6	CO7	L4
	c	Briefly explain representations of TM with example	6	CO8	L3
		OR			
-	a	Prove that every deterministic CFL's are closed under complement	4	CO7	L3
	b	Prove that every deterministic CFL's are not closed under union and intersection .	4	CO7	L3

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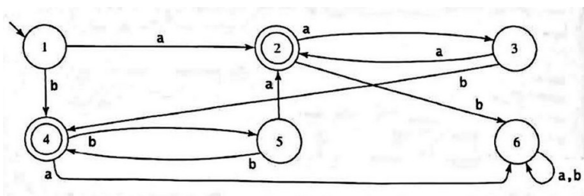
	c	Design TM that accepts $\{1^n 2^n 3^n \mid n \geq 1\}$. Write the ID's for 1223, 1123, 1233 and 112233.	8	CO8	L4
5	a	Explain the following types of TM: a. Multitape TM b. Non deterministic TM	6	CO9	L2
	b	Prove that every language accepted by a multi-tape TM is acceptable by some single-tape TM (that is, the standard TM).	6	CO9	L2
	c	Prove HALT TM = {(M, w) |The Turing machine M halts on input w} is undecidable.	4	CO10	L3
		OR			
-	a	Prove that, if M is a nondeterministic TM, there is a deterministic TM M 1 such that T(M) = T(M 1)	6	CO9	L3
	b	Prove that A TM is undecidable.	6	CO10	L4
	c	Write a note on quantum computation.	4	CO10	L2

2. SEE Important Questions

Course:	Automata Theory & Computability		Month / Year	May /2018	
Crs Code:	15CS54 Sem: 5 Marks: 80		Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	Give Formal definition of DFA. And also Design a DFA to read a string made up of letters"computer" and recognize the strings that contains the word "cut" as a subs tring.	10	CO2	2017
	2	Design a DFA to accept strings of a's and b's not ending with abb	5	CO2	2017
	3	Design the DFA's for the following languages: i)Set of all strings with at least one 'a' and exactly two `b's on E = {a, b}. ii) Set of all strings such that number of 1's is even and the number of 0's is a multiple of 3 on E = {0, 1}.	8	CO2	2016
	4	Design an NFA with no more than 5 states for the following language: $L = \{abab^n \mid n>=0\} U \{aba^n \mid n>=0\}$	6	CO2	2016
	5				2007
2	1	Define regular expression and also write the regular expressions for the following language $L = \{w€ \{a, b\}^*$ w has exactly one pair of consecutive a's}.	4	CO3	2015
	2	Convert the regular expression $(0 + 1)^* (0 + 1)$ to an NFA.	6	CO3	2016
	3	Minimize following DFSMs 	10	CO3	2015
	4	Mention the applications of regular expressions.	2	CO4	2014
	5	State and prove pumping lemma for regular languages.	10	CO4	2014
3	1	Define CFG. Design a context free grammar for the languages: i)$L = \{a^i b^j c^k$, where i = j + k, i, j, k>= 0}. ii) $L = \{01^{n+2} 1^n : n >= 1\}$	8	co5	2014
	2	What is an ambiguous grammar? Show that the grammar shown below is	6		2014

		ambiguous on the string "aab". S —> AB/aaB A —> Aa/a B —>b.			
	3	Define PDA. Describe the language accepted by PDA.	4	CO6	2010
	4	Construct a PDA that accepts the language L = {$a^n b^n$ I n>=1 }. Give the graphical representation for PDA obtained. Show the instantaneous description of the PDA on the input string aaabbb.	10	CO6	2010
	5	What are Useless Productions? Remove all useless productions, unit productions and all s - productions from the grammar : S-4 aA aB • ; A--> aaA I I B 1 I e ; B -> b b B ; D ---> B	10	CO5	2009
4	1	prove that if L is a CFL and R is a regular language then L n R is a CFL.	6	CO7	2011
	2	Define Turing Machine and Instantaneous Descriptions (ID) for Turing machine.	4	CO8	2011
	3	Show that a^n b^n c^n is not a context free language using pumping lemma of CFL	5	CO7	2013
	4	Design a Turing machine to accept $a^n b^n c^n$	8	CO8	2012
	5	Design a Turing machine to accept the set of all palindromes over (0, }*. moves made by Turing machine for the string : 1001.	12	CO8	2011
5	1	Write a note on multitape Wring machine and non-deterministic turing machine.	6	CO9	2013
	2	Write short notes on: a.Post correspondence problem b.Halting problem in TM c.Universal turing machine	15	CO9	2013
	3	Write short notes on the following topics: a.Post's correspondence problem. b.Recursive language and it's relationship with and non-RE languages	10	CO10	2015
	4	Write a short note on Undecidability of ambiguity for CFG's.	4	CO10	2015
	5	Explain the relationship between the recursive, RE and non-RE languages.	6	CO10	2005