Lesson Plan

T.E. (CE- A& B) (Semester V)

Subject: Theoretical Computer Science

Subject code: CSC501

Teacher-in-charge: Prof. Sangeeta Parshionikar

Academic Term: July – October 2022

Module		Content	Hrs
1		**Basic Concepts and Finite Automata**	**9**
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM)	
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε- transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.	
2		**Regular Expressions and Languages**	**7**
	2.1	Regular Expression (RE),Equivalence of RE and FA, Arden's Theorem, RE Applications.	
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.	
3		**Grammars**	**8**
	3.1	Grammars and Chomsky hierarchy	
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.	
	3.3	**Context Free Grammars (CFG)** Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.	

4		**Pushdown Automata(PDA)**	**4**
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	
5		**Turing Machine (TM)**	**9**
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.	
6		**Undecidability**	**2**
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem. .	

Course Objectives:

1. Acquire conceptual understanding of fundamentals of grammars and languages.
2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and pushdown automata.
3. Develop understanding of different types of Turing machines and applications.
4. Understand the concept of Undecidability.

Course Outcomes:

Upon completion of this course students will be able to:

CSC501.1: Identify the concepts Theoretical Computer Science, differentiate between deterministic and non-deterministic automata, also obtain equivalence between NFA and DFA.
CSC501.2: Infer the equivalence of languages described by regular expressions.
CSC501.3: Devise regular, context free grammars while recognizing the strings and tokens.
CSC501.4: Design pushdown automata to recognize the language.
CSC501.5: Develop an understanding of computation through Turing Machine.
CSC501.6: Acquire fundamental understanding of decidability and undecidability.

CO-PO-PSO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CSC501.1	1	2												
CSC501.2	1	1												
CSC501.3	1	2												
CSC501.4	1	1												

CSC501.5	1	1												
CSC501.6	1													

Provide justification of PO to CO mapping

Course Outcome	Competency	Performance Indicator
CSC501.1	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.2 Identify processes/modules of a computer-based system and parameters to solve a problem
	2.3 Demonstrate an ability to formulate and interpret a model	2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
CSC501.2	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.3 Demonstrate an ability to formulate and interpret a model	2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
CSC501.3	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals
	2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.2 Identify processes/modules of a computer-based system and parameters to solve a problem
		2.1.3 Identify an algorithm that applies to a given problem
CSC501.4	1.1 Demonstrate competence in mathematical modelling	1.1.1 Apply the knowledge of discrete structures to solve problems.
	2.1 Demonstrate an ability to identify and formulate complex	2.1.2 Identify processes/modules of a computer-based system and parameters to solve a problem

	engineering problem	
CSC501.5	1.1 Demonstrate competence in mathematical modelling	1.1.1 Apply the knowledge of discrete structures to solve problems.
	2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.2 Identify processes/modules of a computer-based system and parameters to solve a problem
	1.4 Demonstrate competence in specialized engineering knowledge to the program	1.4.1 Apply theory and principles of Computer Science and engineering to solve an engineering problem
CSC501.6	1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamentals

CO Assessment Tools:

Course Outcomes	***Direct Method (80%)***									***Indirect Method (20%)***
	Unit Tests		Assignments					Flipped class	End Sem Exam	Course exit survey
	1	2	1	2	3	4	5	1		
CSC501.1	30%	--	10%	--				10%	50%	100%
CSC501.2	30%	--	--	--				20%	50%	100%
CSC501.3	--	25%	--	25%				--	50%	100%
CSC501.4	--	25%	--		25%			--	50%	100%
CSC501.5	--	25%	--			25%		--	50%	100%
CSC501.6	--	20%	--				30%	--	50%	100%

CO calculation= (0.8 *Direct method + 0.2*Indirect method)

Rubrics for assessing Course Outcome with each assessment tool:

Assignment:

Sr. No.	Parameters	Exceed Expectation (EE)	Meet Expectation (ME)	Below Expectation (BE)
1.	Timeline (2)	Completed before deadline specified (2)	Completed on deadline (1)	Partial / late submission (0)
2.	Level of content / Completeness & neatness(3)	Shows complete understanding of the questions, mathematical Qs etc Complete all parts of assignment : 100 % complete (3)	Shows considerable understanding of the questions, mathematical Qs etc < 80% (2)	Shows a complete lack of understanding for the problem (1)
3.	Knowledge (3)	In depth knowledge of the assignment (3)	Unable to answer 1-2 qs (2)	Just managed (1)
4.	Documentation (2)	Documented in proper format and maintained neatly.(2)	Most of the part is documented in proper format but some formatting guidelines are missed.(1)	not written in proper format (0.5)

Content beyond syllabus:

Guest Lecture on "Application of Automata and Theretical Computer Science".

Modes of content delivery

Modes of Delivery	Brief description of content delivered
Class room lecture	1. Basic Concepts and Finite Automata 2. Regular Expressions and Languages 3. Grammer 4. Pushdown automata 5. Turing Machine 6. Undecidability
Assignments	Assignment 1: Basic Concepts and Finite Automata Assignment 2: Grammer Assignment 3: Pushdown automata Assignment 4: Turing Machine Assignment 5: Undecidability
Flipped class	Activity on Unit 2: Regular Expressions and Languages
NPTEL Video	3: Grammer 4: Pushdown automata
Guest Lecture	Application of Automata and Theretical Computer Science

Text Books:

1. John E, Hopcroft, Rajeev Motwani, Jeffery D. Ullman, "Introduction of Automata Theory, Languages and Computation, Pearson Edition
2. Michael Siper, "Theory of Computation", Cengage Learning
3. Vivek Kulkarni, :Theory of Computation", Oxford University Press. India

Reference Books:

1. J. C. Martin, " Introduction to languages and Theory of Computation", Tata McGraw Hill.
2. Kavi Mahesh, " Theory of Computation: A Problem Solving Approach", Wiley-India.

Lesson Plan

CLASS		TE Computer Engineering (A), Semester V	
Academic Term		July- October 2022	
Subject		**Theoretical Computer Science (CSC501)**	
Periods (Hours) per week	***Lecture***	***3***	
	Practical		
	Tutorial		
Evaluation System		***Hours***	***Marks***
	Theory examination	3	80
	Internal Assessment	--	20
	Practical Examination	--	--
	Oral Examination	--	--
	Term work	--	--
	Total	--	100

Time Table	***Day***	***Time***
	Monday	11.00 - 12.00pm
	Tuesday	1.30 - 2.30pm
	Wednesday	1.30 - 2.30pm

Course Content and Lesson plan

Week	Lecture No	Date		Topic	
		Planned	**Actual**		**Remarks**
Module 1: Basic Concepts and Finite Automata					
1	1	18/07/2022	18/07/2022	Importance of TCS, Course Outcomes	
	2	20/07/2022	20/07/2022	Alphabets, Strings, Languages, Closure Properties.	
	3	21/07/2022	21/07/2022	Finite Automata and Finite State Machine (Divide by 3 – FSM)	
2	4	25/07/2022	25/07/2022	DFA Definition, Transition Diagrams and Language recognizers examples	
	5	27/07/2022	27/07/2022	DFA – Design problems	
	6	28/07/2022	28/07/2022	NFA Definition and Design problems	
3	7	01/08/2022	01/08/2022	NFA to DFA conversion.	
	8	02/08/2022	02/08/2022	NFA with e-transitions and NFA	
	9	03/08/2022	03/08/2022	NFA with e-transitions to DFA	
4	10	08/08/2022	08/08/2022	Minimization of DFA	
	11	09/08/2022	09/08/2022	Minimization of DFA	
	12	10/08/2022	11/08/2022	FSM with output: Moore Machine	

Assignment 1 Given on 10/08/2022 Submission on: 17/08/2022					
5	13	16/08/2022	18/08/2022	FSM with output: Mealy Machine	
	Module 2: Regular Expressions and Languages				
	14	22/08/2022	22/08/2022	Regular Expressions, RE and FA	
	15	23/08/2022	23/08/2022	Arden's Theorem	
6	16	24/08/2022	27/08/2022	Regular Language (RL), Closure and decision properties of RL	Online
Ganapati Holidays					
Unit Test 1 - 5th, 6th and 7th September 2022					
7	16	09/09/2022	09/09/2022	Pumping Lemma of RL	
	Module 3: Grammer				
	17	12/09/2022	12/09/2022	Grammars and Chomsky hierarchy	
	18	13/09/2022	13/09/2022	Regular Grammar(RG), Left linear and Right linear Grammar	
8	19	14/09/2022	14/09/2022	Equivalence of RG and FA	
	20	19/09/2022	19/09/2022	Context Free Grammar: Design, Parse tree and Ambiguity	
	21	20/09/2022	20/09/2022	Chomsky Normal Form	NPTEL Video
Assignment 3 Given on 14/09/2022 Submission on: 19/09/2022 **Assignment 4 Given on 20/09/2022 Submission on: 24/09/2022**					
9	22	21/09/2022	21/09/2022	Greibach Normal Form	
	23	24/09/2022	24/09/2022	CFLs- Pumping Lemma, CFLs- Closure properties	Online
10	***Module 4: Pushdown Automata***				
	24	26/09/2022	26/09/2022	Definition, Language of PDA,	Online
	25	27/09/2022	27/09/2022	Push Down Automata :Definition,	
	26	28/09/2022	28/09/2022	PDA-as generator, decider	
11	27	03/10/2022	03/10/2022	PDA-as acceptor, Deterministic PDA , Non-Deterministic	NPTEL Video
	28	04/10/2022	04/10/2022	Deterministic PDA	
	Module 5: Turing Machine				
	29	07/10/2022	07/10/2022	Turing Machine: Definition, Turing Machine as generator	

12	30		08/10/2022	**Application of Automata & TCS**	**Guest Lecture**
	31	10/10/2022	10/10/2022	Turing Machine as generator, acceptor	Online
	32	11/10/2022	11/10/2022	Variants of Turing Machine,	
13	33	12/10/2022	12/10/2022	Equivalence of single and Multi-tape TMs, Applications, Powers and Limitations	
	Module 6: Undecidibility				
	UT 2 - 17th to 19th October 2022				
	35	20/10/2022	20/10/2022	Decidability and Undecidability, Halting Problem	
14	36	21/10/2022	21/10/2022	Recursive and Recursively Enumerable Languages, Rice's Theorm	
Assignment 5		**Given on 10/10/2022**		**Submission on: 15/10/2022**	
Assignment 6		**Given on 15/10/2022**		**Submission on: 20/10/2022**	
Total	36				

Lesson Plan

CLASS	TE Computer Engineering (B), Semester V		
Academic Term	July- October 2022		
Subject	**Theoretical Computer Science (CSC501)**		
Periods (Hours) per week	***Lecture***	***3***	
	Practical		
	Tutorial		
Evaluation System		***Hours***	***Marks***
	Theory examination	3	80
	Internal Assessment	--	20
	Practical Examination	--	--
	Oral Examination	--	--
	Term work	--	--
	Total	--	100

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	Thursday	12.00 - 1.00pm

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	2	21/07/2022	21/07/2022	Alphabets, Strings, Languages,	
	3	22/07/2022	22/07/2022	Finite Automata and Finite State Machine (Divide by 3 – FSM)	
2	4	27/07/2022	27/07/2022	DFA Definition, Transition Diagrams and Language recognizers examples	
	5	28/07/2022	28/07/2022	DFA – Design problems	
	6	29/07/2022	29/07/2022	NFA Definition and Design problems	
3	7	01/08/2022	01/08/2022	NFA to DFA conversion.	
	8	03/08/2022	03/08/2022	NFA with e-transitions and NFA	
	9	04/08/2022	04/08/2022	NFA with e-transitions to DFA	
4	10	08/08/2022	08/08/2022	Minimization of DFA	
	11	10/08/2022	09/08/2022	Minimization of DFA	
	12	11/08/2022	11/08/2022	FSM with output: Moore Machine	

Assignment 1		**Given on 10/08/2022**		**Submission on: 17/08/2022**	
5	13	17/08/2022	16/08/2022	FSM with output: Mealy Machine	
	Module 2: Regular Expressions and Languages				
	14	18/08/2022	18/08/2022	Regular Expressions, RE and FA	
	15	22/08/2022	22/08/2022	Arden's Theorem	
6		24/08/2022	27/08/2022	Regular Language (RL), Closure and desicion properties of RL	Online
Ganapati Holidays					
Unit Test 1 - 5th, 6th and 7th September 2022					
7	16	08/09/2022	08/09/2022	Pumping Lemma of RL	
	Module 3: Grammer				
	17	12/09/2022	12/09/2022	Grammars and Chomsky hierarchy	
	18	14/09/2022	14/09/2022	Regular Grammar(RG), Left linear and Right linear Grammar	
8	19	15/09/2022	15/09/2022	Equivalence of RG and FA	
	20	19/09/2022	19/09/2022	Context Free Grammar: Design, Parse tree and Ambiguity	
	21	21/09/2022	21/09/2022	Chomsky Normal Form	NPTEL Video
Assignment 3		**Given on 14/09/2022**		**Submission on: 19/09/2022**	
Assignment 4		**Given on 20/09/2022**		**Submission on: 24/09/2022**	
9	22	22/09/2022	23/09/2022	Greibach Normal Form	
	23	24/09/2022	24/09/2022	CFLs- Pumping Lemma, CFLs- Closure properties	Online
10	***Module 4: Pushdown Automata***				
	24	26/09/2022	26/09/2022	Simplification and Applications	Online
	25	28/09/2022	28/09/2022	Push Down Automata :Definition,	
	26	29/09/2022	29/09/2022	PDA-as generator, decider	
11	27	03/10/2022	03/10/2022	PDA-as acceptor	NPTEL Video
	28	04/10/2022	04/10/2022	Deterministic PDA	
	Module 5: Turing Machine				
	29	07/10/2022	07/10/2022	Turing Machine: Definition, Turing Machine as generator	
12	30		08/10/2022	**Application of Automata & TCS**	**Guest Lecture**

	31	10/10/2022	10/10/2022	Turing Machine as generator, acceptor	Online
	32	12/10/2022	12/10/2022	Variants of Turing Machine,	
13	33	13/10/2022	13/10/2022	Equivalence of single and Multi-tape TMs, Applications, Powers and Limitations	
	Module 6: Undecidibility				
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	35	20/10/2022	20/10/2022	Decidability and Undecidability, Halting Problem	
14	36	21/10/2022	21/10/2022	Recursive and Recursively Enumerable Languages, Rice's Theorm	
Assignment 5		**Given on 10/10/2022**		**Submission on: 15/10/2022**	
Assignment 6		**Given on 15/10/2022**		**Submission on: 20/10/2022**	
Tota	**36**				