NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

COURSE PLAN – PART I			
Name of the programme and specialization	**B.TECH / CSE**		
Course Title	**Automata and Formal languages**		
Course Code	**CSPC41**	**No. of Credits**	**4**
Course Code of Pre-requisite subject(s)	**CSPC11**		
Session	~~July~~/ **January 2021**	**Section (if, applicable)**	**A / ~~B~~**
Name of Faculty	**Dr. Rajeswari Sridhar**	**Department**	**CSE**
Official Email	srajeswari@nitt.edu	**Telephone No.**	
Name of Course Coordinator(s) (if, applicable**)**	--		
Official E-mail		**Telephone No.**	
Course Type (please tick appropriately**)**	√ **Core course**	☐ **Elective course**	

Syllabus (approved in Senate)

Unit – I Introduction:

Alphabets, Strings and Languages; Automata and Grammars, Deterministic finite Automata (DFA)-Formal Definition, Simplified notation: State transition graph, Transition table, Language of DFA, Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Equivalence of NFA and DFA, Minimization of Finite Automata, Distinguishing one string from other, Myhill-Nerode Theorem

Unit – II Regular Expression (RE):

Definition, Operators of regular expression and their precedence, Algebraic laws for Regular expressions, Kleen's Theorem, Regular expression to FA, DFA to Regular expression, Arden Theorem, Non Regular Languages, Pumping Lemma for regular Languages. Application of Pumping Lemma, Closure properties of Regular Languages, Decision properties of Regular Languages, FA with output: Moore and Mealy machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.

Unit – III Context Free Grammar (CFG) and Context Free Languages:

Definition - Examples - Derivation - Derivation trees - Ambiguity in Grammar - Inherent ambiguity - Ambiguous to Unambiguous CFG - Useless symbols - Simplification of CFGs - Normal forms for CFGs: CNF and GNF - Closure properties of CFLs - Decision Properties of CFLs: Emptiness - Finiteness and Membership - Pumping lemma for CFLs.

Unit – IV Push Down Automata (PDA):

Description and definition - Instantaneous Description - Language of PDA - Acceptance by Final state - Acceptance by empty stack - Deterministic PDA - Equivalence of acceptance by empty stack and final state - Conversion of CFG to PDA and PDA to CFG.
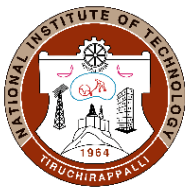
Unit – V Turing machines (TM) and Undecidability:

Basic model - definition and representation - Instantaneous Description - Language acceptance by TM - Variants of Turing Machine - TM as Computer of Integer functions - Universal TM - Church"s Thesis - Recursive and recursively enumerable languages - Halting problem - Introduction to Undecidability - Undecidable problems about TMs - Post correspondence problem (PCP) - Modified PCP and undecidable nature of post correspondence problem - Introduction to recursive function theory.

Text Book

1. Hopcroft and Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education, 3rd edition, 2014

Reference books

1. Martin J. C., "Introduction to Languages and Theory of Computations", TMH, 4th edition, 2010
2. Peter Linz, "An Introduction to Formal Language and Automata", Narosa Pub. House, 2011
3. Papadimitriou, C. and Lewis, C. L., "Elements of the Theory of Computation", PHI, 1997

COURSE OBJECTIVES

- To know about Chomsky hierarchy for organizing languages
- To introduce concepts in automata theory and theory of computation
- To identify different formal language classes and their relationships
- To design grammars and recognizers for different formal languages
- To understand undecidability and decide on languages that are undecidable

MAPPING OF COs with POs

| Course Outcomes Upon completion of the course, students will be able to	Programme Outcomes (PO) (Enter Numbers only)
1. Design finite automata or regular expression for any tokenization task	**1,3,5,7,9**
2. Construct a context free grammar for parsing any language	**1, 3, 6,7,11,12**
3. Design Turing machine for any language	**1, 3, 6,7**
4. Conclude the decidable / undecidable nature of any language	**1, 5, 8, 11**
5. Apply mathematical and formal techniques for solving real-world problems	**1, 3, 6, 12**

COURSE PLAN – PART II

COURSE OVERVIEW

Chomsky hierarchy dictates languages based on representing using Type 0, 1, 2,3 grammar. This course serves as the foundation for language representation which is subsequently used for different concepts in the field of computer science.

| **COURSE TEACHING AND LEARNING ACTIVITIES**			(Add more rows)
S.No.	Week/Contact Hours	Topic	Mode of Delivery (Online MS Teams)
1	18/01/2021 to 22/01/2021 2 hours	Unit 1: Alphabets, Strings, Languages, Examples, Operators of Regular expression, Type 0, 1,2 ,3 grammar, Finite Automata, DFA,	PPT, MS Whiteboard
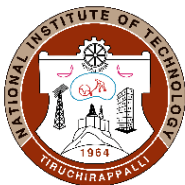
		Examples	
2	18/01/2021 to 22/01/2021 1 hour 25/01/2021 to 29/01/2021 1 hour	DFA problems, NFA, definition, problems, NFA & DFA equivalence, Problems	PPT, MS Whiteboard
3	25/01/2021 to 29/01/2021 1 hour 01/02/2021 to 05/02/2021 1 hour	NFA with epsilon transitions, Equivalence of epsilon NFA and DFA	PPT, MS Whiteboard
4	01/02/2021 to 05/02/2021 2 hours	Equivalence of epsilon NFA and DFA – Problems Operators of regular expression, precedence,	PPT, MS Whiteboard
5	01/02/2021 to 05/02/2021 1 hour 08/02/2021 to 12/02/2021 1 hour	Unit 2: Regular expression to Epsilon NFA, Problems, Equivalence	PPT, MS Whiteboard
6	08/02/2021 to 12/02/2021 3 hours	Arden's theorem, Kleene's theorem, Proof	PPT, MS Whiteboard
7	15/02/2021 to 19/02/2021 2 hours	Properties of Regular languages – Problems based on the same	PPT, MS Whiteboard
8	15/02/2021 to 19/02/2021 2 hours	Pumping lemma for regular languages, proof, Moore and Mealy machines	PPT, MS Whiteboard
9	22/02/2021 to 26/02/2021 2 hours	Equivalence of Moore and Mealy machines, Applications and Limitations of FA	PPT, MS Whiteboard
10	22/02/2021 to 26/02/2021 2 hours	Convert from Moore Machine to Mealy and Vice-versa problems	PPT, MS Whiteboard
11	01/03/2021 to 05/03/2021 1 hour	Cycle Test 1	Online through MS Teams

12	08/03/2021 to 12/03/2021 2 hours	Unit 3: Context Free Grammar – definition, Example, Derivation, Trees, LMD, RMD, Parse trees, Ambiguity, Ambiguous grammar, Equivalence	PPT, MS Whiteboard
13	08/03/2021 to 12/03/2021 2 hours	Grammar to useful grammar, Epsilon production, Unit Production, Useless symbol	PPT, MS Whiteboard
14	15/03/2021 to 19/03/2021 2 hours	Chomsky Normal Form, Greibach Normal form – Equivalence, Problems	PPT, MS Whiteboard
15	15/03/2021 to 19/03/2021 2 hours	Properties of CFL	PPT, MS Whiteboard
16	22/03/2021 to 26/03/2021 2 hours	Unit 4: Push Down automata, Definition, problems	PPT, MS Whiteboard
17	22/03/2021 to 26/03/2021 2 hours	Deterministic PDA, Non-deterministic PDA, String acceptance	PPT, MS Whiteboard
18	29/03/2021 to 02/04/2021 1 hour	Cycle Test 2	Online
19	05/04/2021 to 09/04/2021 2 hours	Equivalence of acceptance by Final state and acceptance by Empty stack	PPT, MS Whiteboard
20	05/04/2021 to 09/04/2021 2 hours	Equivalence of PDA and CFG	PPT, MS Whiteboard
21	12/04/2021 to 16/04/2021 2 hours	Equivalence of PDA and CFG, Pumping lemma for CFG	PPT, MS Whiteboard
22	12/04/2021 to 16/04/2021 2 hours	Problems based on Equivalence of PDA and CFG	PPT, MS Whiteboard
23	19/04/2021 to 23/04/2021 2 hours	Unit 5: Turing Machine – Definition, Representation, Instantaneous description, Problems	PPT, MS Whiteboard
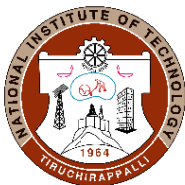
24	19/04/2021 to 23/04/2021 2 hours	Language accepted by TM – Problems	PPT, MS Whiteboard
25	26/04/2021 to 30/04/2021 2 hours	TM as computing Device – Problems, Variations of TM, TM Techniques	PPT, MS Whiteboard
26	26/04/2021 to 30/04/2021 2 hours	Recursive and Recursively enumerable languages	PPT, MS Whiteboard
27	03/05/2021 to 07/05/2021 2 hours	Universal Turing machine – Undecidability nature, PCP and MPCP problems	PPT, MS Whiteboard

COURSE ASSESSMENT METHODS (shall range from 4 to 6)

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Cyle Test 1	01/03/2021 to 05/03/2021 2 hours	1 hour	20
2	Cycle Test 2 (cumulative Surprise Tests)	29/03/2021 to 02/04/2021	20 minutes each test	20
3	Assignment 1	21/02/2021 to 25/02/2021	2 hours	10
4	Programming Assignment	26/04/2021 to 30/04/2021	6 hours	20
CPA	Compensation Assessment*			
5	Final Assessment *	As per academic schedule	As per institute guidelines	30

*mandatory; refer to guidelines on page 4

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1. **Students' feedback through PAC meetings**
2. **Feedbacks are collected before final examination through MIS or any other standard format followed by the institute**
3. **Students, through their Class Representatives, may give their feedback at any time to the course faculty which will be duly addressed.**
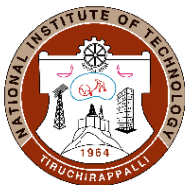
COURSE POLICY (including compensation assessment to be specified)

MODE OF CORRESPONDENCE (email/ phone etc)
Email
COMPENSATION ASSESSMENT POLICY
1. One compensation assessment will be given after completion of Cycle Test 1 and 2 for the students those who are absent for any assessment

due to genuine reason.
2. No compensations for the surprise tests. n-1 surprise tests of the 'n' surprise tests will be considered for CT2
3. Compensatory assessments would cover the syllabus of Cycle tests 1 & 2
4. The prior permission and required documents must be submitted for absence signed by HoD/CSE.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

➢ At least 75% attendance in each course is mandatory.

➢ A maximum of 10% shall be allowed under On Duty (OD) category.

➢ Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

➢ Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.

➢ Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.

➢ The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

➢ The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION, IF ANY

1. **The Course Coordinator is available for consultation during the time intimated to the students then and there.**
2. **Relative grading adhering to the instructions from the office of the Dean (Academic) will be adopted for the course.**

FOR APPROVAL

Course Faculty _____   **CC- Chairperson** _____   **HOD** _____

18th January 2021
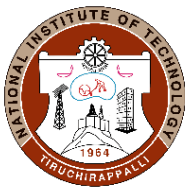
Guidelines

a) The number of assessments for any theory course shall range from 4 to 6.

b) Every theory course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in				P.G.
2018	**2017**	**2016**	**2015**	
35% or (Class average/2) whichever is greater.		(Peak/3) or (Class Average/2) whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.