A

Course File Report

On

"Formal Languages and Automata Theory"

Submitted by

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CONTENTS OF COURSE FILE:

DEPARTMENT VISION & MISSION

VISION:

To produce globally competent and industry ready graduates in Computer Science & Engineering by imparting quality education with a know-how of cutting edge technology and holistic personality.

MISSION:

M1. To offer high quality education in Computer Science & Engineering in order to build core competence for the students by laying solid foundation in Applied Mathematics, and program framework with a focus on concept building.
M4. The department promotes excellence in teaching, research, and collaborative activities to prepare students for professional career or higher studies.
M3. Creating intellectual environment for developing logical skills and problem solving strategies, thus to develop, able and proficient computer engineer to compete in the current global scenario.

LIST OF PEOS, POS & PSOs

2.1 PROGRAM EDUCATIONAL OBJECTIVES (PEO):

PEO 1: Excel in professional career or higher education by acquiring knowledge in mathematical, computing and engineering principles.
PEO 2: To provide intellectual environment for analyzing and designing computing systems for technical problems socially and economically.

PEO 3: Exhibit professionalism, multidisciplinary teamwork and adapt to current trends by engaging in lifelong learning and practice their profession with legal and ethical responsibilities.

2.2 .PROGRAM OUTCOMES:

- **PO1. Engineering Knowledge:**

  An ability to apply knowledge of computing, mathematics, science and engineering fundamentals appropriate to the discipline.

- **PO2.Problem Analysis:**

  An ability to analyze a problem, and identify and formulate the computing requirements appropriate to its solution.

- **PO3.Design/Development Of Solutions:**

  An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

- **PO4**. **Conduct Investigations Of Computer Programs:**

  An ability to design and conduct experiments, as well as to analyze and interpret data.

- **PO5**. **Modern Tool Usage:**

  An ability to use current techniques, skills, and modern tools necessary for computing practice.

- **PO6.The Engineer And Society:**

An ability to analyze the local and global impact of computing on individuals, organizations, and society.

- **PO7. Environment And Sustainability:**

  Knowledge of contemporary issues.

- **PO8. Ethics**:

  An understanding of professional, ethical, legal, security and social issues and responsibilities.

- **PO9. Individual And Team Work;**

  An ability to function effectively individually and on teams, including diverse and multidisciplinary, to accomplish a common goal.

- **PO10. Communication**:

  An ability to communicate effectively with a range of audiences.

- **PO11. Project Management And Finance** :

  An understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects.

- **PO12.life long-learning**:

  Recognition of the need for and an ability to engage in continuing professional development.

2.3. PROGRAM SPECIFIC OUTCOMES (PSO's)

PSO1: **Professional Skills and Foundations of Software development:** Ability to analyze, design and develop applications by adopting the dynamic nature of Software developments.

PSO2: **Applications of Computing and Research Ability**: Ability to use knowledge in cutting edge technologies in identifying research gaps and to render solutions with innovative ideas.

3. LIST OF CO's (ACTION VERBS AS PER BLOOM'S TAXONOMY)

COURSE OUTCOMES:

COURSE OUTCOMES **COURSE NAME: FORMAL LANGUAGES AND AUTOMATA THEORY** **COURSE CODE: C301**	
C301.1	**Define** grammar and automata with rigorously formal mathematical methods.**(Remembering)**
C301.2	**Interpret** regular expressions and context-free grammars accepting or generating a certain language**.(Understanding)**
C301.3	Explain about the language accepted by automata or generated by a regular expression or a context-free grammar. **(Understanding)**
C301.4	Define push down automata to determine acceptance by final state. **(Remembering)**
C301.5	**Design** complex problems and determine decidability of problems**. (Creating)**

4. Syllabus copy

UNIT-I

Fundamentals : Structural Representations,Automata and Complexity, the Central Concepts of Automata Theory-Alphbets, Strings, Languages, Problems.

Non deterministic finite automata: Formal definitions, finite automata model, acceptance of strings, and languages, deterministic finite automaton and non deterministic finite automaton, transition diagrams and Language recognizers. **Finite Automata**: NFA with Î transitions - Significance, acceptance of languages. Conversions and Equivalence: Equivalence between NFA with and without e-transitions, NFA to DFA conversion, minimization of FSM, equivalence between two FSM's, Finite Automata with output- Moore and Melay machines.

UNIT –II

Regular expressions:

Regular Languages: Regular sets, regular expressions, identity rules, Constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Pumping lemma of regular sets, closure properties of regular sets (proofs not required).

UNIT – III

Context Free Grammars: Regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and FA, inter conversion, Context free grammar, derivation trees, sentential forms. Right most and leftmost derivation of strings.

Push Down Automata: Push down automata, definition, model, acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, interconversion. (Proofs not required). Introduction to DCFL and DPDA.

UNIT – IV

Context Free Grammars : Ambiguity in context free grammars. Minimisation of Context Free Grammars. Chomsky normal form, Greiback normal form, Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted).

Turing Machine: Turing Machine, definition, model, design of TM, Computable functions, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs not required). linear bounded automata and context sensitive language,

UNIT – V

Undecidability: decidability of, problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility, Definition of P and NP problems, NP complete and NP hard problem.

4.1 References (Text books/websites/Journals)

Text books

T1. "Introduction to Automata Theory Languages and Computation".

Hopcroft H.E. and Ullman J. D. Pearson Education

T2.Introduction to Theory of Computation -Sipser 2nd edition Thomson

REFERENCE BOOKS

R1. Introduction to Computer Theory, Daniel LA. Cohen, John Wiley.

R2.Introduction to languages and the Theory of Computation, John C Martin, TMH

R3."Elements of Theory of Computation", Lewis H.P. & Papadimition C.H. Pearson! PHI.

R4.Theory of Computer Science - Automata languages and computation -Mishra and Chandrashekaran, 2nd edition, PHI

5. Session plan

S.NO	TOPIC TO BE COVERED	Suggested Books (Eg. T1, T2,R1)	NO. OF LECTURES REQUIRED
	UNIT – I		
1	Strings, Alphabet, Language, Operations	T1,T2	1
2	Finite state machine, definitions, finite automaton model	T1,R1	2
3	Acceptance of strings, and languages	T1,R1	2
4	Deterministic finite automaton and non deterministic finite automata	T1,T2	1
5	Transition diagrams and Language recognizers.	T1,T2	1
1	NFA with Î transitions - Significance, acceptance of languages. Conversions and Equivalence	T1,T2	2
2	Equivalence between NFA with and without Î transitions, NFA to DFA conversion, minimisation of FSM	T1,R1	2

3	Equivalence between two FSM's, Finite Automata with output- Moore and Melay machines.	T1,T2,R1	3
UNIT-II			
1	Regular sets, regular expressions, identity rules, Constructing finite Automata for a given regular expressions	T1	2
2	Conversion of Finite Automata to Regular expressions	T1	1
3	Pumping lemma of regular sets	T1	2
4	Closure properties of regular sets (proofs not required).	T1	1
UNIT – III			
1	Regular grammars- right linear and left linear grammars,	T1	2
2	Equivalence between regular linear grammar and FA	T1	2
3	Inter conversion, Context free grammar	T1	2
4	Derivation trees, sentential forms	T1	2

5	Right most and leftmost derivation of strings Ambiguity in context free grammars.	T1	2
UNIT-IV			
1	Minimisation of Context Free Grammars	T1,R2	2
2	Chomsky normal form, Greiback normal form	T1	1
3	Pumping Lemma for Context Free Languages	T1	2
4	Enumeration of properties of CFL	T1	2
1	Push down automata, definition, model, acceptance of CFL	T1,R2	2
2	Acceptance by final state and acceptance by empty state and its equivalence	T1,R1	1
3	Equivalence of CFL and PDA, interconversion.	T1	2

4	Introduction to DCFL and DPDA	T1	2
1	Turing Machine, definition, model, design of TM	T1	2
2	Computable functions,	T1,R2	2
3	Recursively enumerable languages	T1,R1	2
4	Church's hypothesis, counter machine	T1	2
5	Types of Turing machines	T1	2
UNIT-V			
1	Decidability of, problems	T1	2
2	Undecidability of posts. Correspondence problem	T1	2
3	Decidability of, problemsTuring Machine,	T1	2
4	Definition of P and NP problems, NP complete and NP hard problems.	T1	2

INDIVIDUAL TIME TABLE(A. DIVYA REDDY)

Mr. A. DIVYA REDDY								WL=18
	I(9:10-10:10)	II(10:10-11:00)	III(11:00-11:50)	IV(11:50-12:40)		V(1:20-2:20)	VI(2:20-3:10)	VII(3:10-4:00)
MON						III-A		III-C
TUE	III-A flat					III-C		III-A
WED		III-A flat					III-C CN	
THU								
FRI			III-C flat					
SAT		III-A flat		III-C flat				

6. Session Execution Log

S No	Unit	Scheduled completed date	Completed date	Remarks
1	I	11-07-2022	1-08-2022	COMPLETED
2	II	2-08-2021	23-08-2021	COMPLETED
3	III	24-08-2021	19-09-2021	COMPLETED
4	IV	27-09-2021	15-10-2021	COMPLETED
5	V	11-10-2022	16-11-2022	COMPLETED

7. Lecture Notes

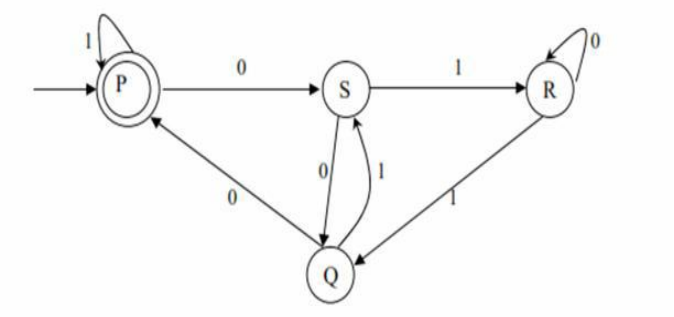
8. Assignment Questions along with sample Assignment Script

Assignment-1

1. Obtain a DFA to accept strings of a's and b's having even number of a's and b's . **[CO1]**
2. Draw a DFA to accept string of 0's and 1's ending with the string 011. **[CO1]**
3. Convert following NFA to DFA **[CO2]**
4. Construct a Finite Automata equivalence to the regular expression (0+1)*(00+11)(0+1)* **[CO2]**
5.

δ_N	0	1
□ p	{p,r}	{q}
q	{r,s}	{p}
*r	{p,s}	{r}
*s	{q,r}	**I**

6. Convert the following DFA to Regular Expression **[CO2]**



Assignment-2

1. a) **Design** Push Down Automata for the language **L={wcw^R | w Є(0+1)*}** **[CO3]**

b)Convert the following Context Free Grammar (CFG) to Chomsky Normal Form

S→Ab/aaB,

A→Є

B→bbA/Є **[CO3]**

2 a) Show that **L={a^n b^n c^n n>=0}** is not a CFL **[CO3]**

b) Enlist various closure Properties of CFL's. **[CO3]**

3.a) **Construct** the Turing machine for the language **L={ a^{n}b^{2n}|n>=1}.** **[CO4]**

b)**Design** Turing Machine for the Language L={**a^{n}b^{n}c^n/n≥1**}. **[CO4]**

4. a) **Explain** about various types of TuringMachine **[CO4]**

b)**Construct** a PDA for the following grammar**S→AA/a,A→SA/b.** **[CO3]**

5 a)**Explain** about the Decidability andUndecidabilityProblems. **[CO5]**

b)Construct PDA for L={X Є {a,b}*| n$_a$ (X)> n$_b$(X)}. **[CO4]**

6.a)Verify whether the following PCP has solutions or not?

A={ba,ab,a,baa,b},B={bab,baa,ba,a,aba} **[CO5]**

b)**Explain** about Counter Machines. **[CO5]**

9.Mid exam Question Papers along with sample Answer Scripts

MID-1

Mid Questions along with sample Assignment Script

1.Obtain a DFA to accept strings of a's and b's having even number of a's and b's **. [CO1]**

2.Draw a DFA to accept string of 0's and 1's ending with the string 011. **[CO1]**

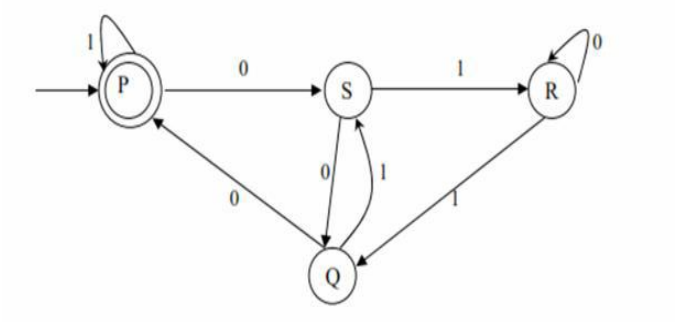
3.Convert following NFA to DFA **[CO2]**

4.Construct a Finite Automata equivalence to the regular expression (0+1)*(00+11)(0+1)* **[CO2]**

5. Construct Finite automata using following Transition table. **[CO2]**

δ_N	0	1
□ p	{p,r}	{q}
q	{r,s}	{p}
*r	{p,s}	{r}
*s	{q,r}	**I**

7. Convert the following DFA to Regular Expression **[CO2]**



MID-2

PART-A **5X2=10**

1.Discuss the applications of Push down Automata.. (CO1)

2.Write short note on Recursively Enumerable languages.(CO6)
3.Define Chomsky Normal Form.(CO1)
4.Write about dicidability of problems.(CO3)
5.StatepumpingLemma for context free Languages. (CO1)

PART-B **3X5=15**

ANSWER ANY THREE QUESTIONS FROM THE FOLLOWING

6. a) Design Push Down Automata for the language **L={wcw^R | w €(0+1)*}** **[CO1] [2+3]**

b)Convert the following Context Free Grammar (CFG) to Chomsky Normal Form

S→a
B |
aaB
A→€
B→bbA|€ [CO3]

OR

7. a) Construct the Turing machine for the language **L={ a^{n}b^{2n}|n>=1}.** [CO1] **[2+3]**
b) Enlist various closure Properties of CFL's. [CO3]

8. a) Show that **L={a^n b^n c^n n>=0}** is not a CFL. [CO2]

b)Design Turing Machine for the Language L={**a^{n}b^{n}c^n/n≥1**}. [CO1]

OR

9. a) Explain about various types of TuringMachine [CO3] **[2+3]**

b)Construct a PDA for the following grammar**S→AA/a,A→SA/b.** [CO1]

10. a)Explain about the Decidability andUndecidabilityProblems. [CO3] **[2+3]**

b)Construct PDA for L={X Є {a,b}*| $n_a(X) > n_b(X)$}. [CO1]

OR

11.a)Verify whether the following PCP has solutions or not?
A={ba,ab,a,baa,b},B={bab,baa,ba,a,aba} [CO2]**[2+3]**

b)Explain about Counter Machines. [CO3**]**

10.Scheme of Evaluation

Questions Number	Scheme of evaluation	Marks allotted
1	Definition	2
2	Design	2
3	Definition	2
4	Find	2
5	Definition	2
6	a) design b) conversion	2 3
7	a) Construct b)List	2 3
8	a)Proving b) Design	2 3
9	a) Explain b) Construct	2 3
10	a) Explain b) Construct	2 3
11	a)Verify b)Explain	2 3

11. Mappings of Cos with Pos and PSOs

COURSE	Relationship of Course outcomes to Program Outcomes (PO AVG)													
COPO&PSO MATRIX	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C301.1	3	2	2	-	-	1	-	-	-	-	-	-	1	-
C301.2	2	3	-	-	-	-	-	-	-	-	-	-	1	-
C301.3	-	2	3	-	-	-	-	-	-	-	-	-	1	-
C301.4	2	2	3	1	-	-	-	-	-	-	-	-	1	-
C301.5	1	2	1	3	-	-	-	-	-	-	-	-	1	-

12. Attainment of COs, POs and PSOs

Justification:

CO1 : **Define** grammar and automata with rigorously formal mathematical methods.
Correlated with PO1 High: Basic Mathematics knowledge such as set theory, relations, functions and proof methods (induction, deduction, and contradiction) are used for verification of properties. Apply theory and principles of computer science engineering to solve an engineering problem.
Correlated with PO2 moderately: As this course outcome provides students identify different utilities but cannot contribute a solution to research problems, Complex Problems. So, overall the correlation of CO1 is good.
Correlated with PO3 moderately: It contributes to identify the problems that arises but, cannot provide a complete solution to Complex problems. Ability to explore design alternatives.
Correlated with PO6 Low: Describe requirement for continuing professional development.
Correlated with PSO1 Low : The skills of designing Finite state machines are relevant to design secure network systems.

CO2:. **Interpret** regular expressions and context-free grammars accepting or generating a certain language.
Correlated with PO1 moderately: Apply theory and principles of computer science

engineering to solve an engineering problem.
Correlated with PO2 High:
Correlated with PSO1 Low: The skills of designing Finite state machines are relevant to design secure network systems..

CO3: Explain about the language accepted by automata or generated by a regular expression or a context-free grammar.
Correlated with PO4 moderately: contribution of this course outcome is weak for providing solutions for complex problems i.e in research area. The correlation is moderate.
Correlated with PO5 moderately: the CO contributes knowledge on different techniques on message passing among processes such that the student gets knowledge on using modern tools. So, the correlation of CO is Good.
Correlated with PO12 moderately: Students get knowledge on different techniques of message passing so that it motivates student to learn new technologies. The correlation is moderate.
Correlated with PSO1 Low : The skills of designing Finite state machines are relevant to design secure network systems.

CO4:. **Define** push down automata to determine acceptance by final state.
Correlated with PO1 moderately: Because it contributes the knowledge on fundamentals of Linux file processing utilities which makes students get engineering knowledge and student can categorize different utilities. So, overall the correlation of CO1 to PO1 is good.
Correlated with PO2 moderately: as this course outcome provides students identify different Problems that occur when dealing with processes but cannot provide better solution for solving the issues So, overall the correlation of CO1 is good.
Correlated with PO3 High: outcome contributes better for identification of different solutions for problems. So, that the students can apply to build some applications. So the correlation is high.
Correlated with PSO1 Low : The skills of designing Finite state machines are relevant to design secure network systems.

CO5: **Design** complex problems and determine decidability of problems**. (Creating)**
Correlated with PO1 (low): The outcome contributes to apply the computer science knowledge so that the correlation is very good.
Correlated with PO2 modeately: the outcome will contribute to indentify the problems and design the application so the correlation is very good.
Correlated with PO3(low): outcome contributes for providing solutions for complex problems only. It may not provide scope for research so the outcome is correlated moderately.
Correlated with PO4 High: outcome contributes to limited scope usage of modern tools. So, it is correlated moderately.
Correlated with PSO1 Low : The skills of designing Finite state machines are relevant to design secure network systems.

13. University Question Papers

14.Power Point Presentations (PPTs)

15.Websites/URLs/ e- Resources

- http://www.cse.chalmers.se/edu/course/TMV027/
- http://books.google.co.in/books?id=tzttuN4gsVgC&source=gbs_similarbook
- http://www.computersciencemcq.com/mcq.
- http://en.wikipedia.org/wiki/Formal_language
- http://en.wikipedia.org/wiki/Automata_theory
- http://cs.fit.edu/~dmitra/FormaLang/