MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

COURSE FILE

OF

FORMAL LANGUAGES AND AUTOMATA THEORY

(IT 051X11)

Faculty Name:

RAJEEV KUMAR

GUEST ASSISTANT PROFESSOR

DEPARTMENT OF INFORMATION TECHNOLOGY

CONTENTS

Department of Information Technology

Vision

To achieve global standard in quality of education, research & development in Information Technology by adapting to the rapid technological advancement to empowering the IT-industry with the wings of knowledge and power of innovation though knowledge creation, acquisition and dissemination for the benefit of Society and Humanity.

Mission

- To produce well-rounded, up to date, scientifically tempered, design oriented engineer and scientists capable of lifelong learning.
- To produce technologically competent and ethically responsible graduates through balanced and dynamic curriculum.
- To develop highly analytical and qualified IT engineers by imparting training on cutting edge technology professional ethics to make the nation as a knowledge power.
- To generate high quality knowledge resource in area of Information Technology and in emerging area to make valuable contribution in IT-Sector for social and economic development of nation and to make organized for identification, monitoring and control of objective attributes of quality for continuous enhancement of academic progress, infrastructure and ambience.

Information Technology Program Educational Objectives

After 4 to 5 years of graduation a B. TECH (IT) graduate would be able to
Graduates of the program will be employed in the computing profession, and will be engaged in learning, understanding, and applying new ideas and technologies as the field evolves.

Graduates with an interest in, and aptitude for, advanced studies in computing will have completed, or be actively pursuing, graduate studies in computing.

Graduates will be informed and involved members of their communities, and responsible engineering and computing professionals who take appropriate account, in their professional work, of such issues as privacy, security, copyright etc. in ways that are consistent with the ACM/IEEE Code of Conduct.

Information Technology Student Outcomes

Students who complete the B. TECH degree in IT will be able to:

i. an ability to apply knowledge of computing, mathematics including discrete mathematics as well as probability and statistics, science, and engineering;
    a. an ability to design and conduct experiments, as well as to analyse and interpret data;
    b. an ability to design, implement, and evaluate a software or a software/hardware system, component, or process to meet desired needs within realistic constraints such as memory, runtime efficiency, as well as appropriate constraints related to economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability considerations;
    c. an ability to function on multi-disciplinary teams;
    d. an ability to identify, formulate, and solve engineering problems;
    e. an understanding of professional, ethical, legal, security and social issues and responsibilities;
    f. an ability to communicate effectively with a range of audiences;
    g. an ability to analyse the local and global impact of computing on individuals, organizations, and society;
    h. a recognition of the need for, and an ability to engage in life-long learning and continuing professional development;
    i. a knowledge of contemporary issues;
    j. an ability to use the techniques, skills, and modern engineering tools necessary for practice as a IT professional;
    k. an ability to analyse a problem, and identify and define the computing requirements appropriate to its solution;
    l. an ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modelling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices;
    m. an ability to apply design and development principles in the construction of software systems of varying complexity.

Course Description

- An **automaton** is a construct that possesses all the indispensable features of a digital computer.
- It accepts input, produces output, may have some temporary storage and can make decisions in transforming the input into the output.
- A **formal language** is an abstraction of the general characteristics of programming languages.
- A formal language consists of a set of symbols and some rules of formation by which these symbols can be combined into entities called sentences.

Course Objectives

- To present the theory of finite automata as the first step towards learning advanced topics such as compiler design.
- To discuss the applications of finite automata towards text processing.
- To develop an understanding of Regular expressions and context free grammars and how these concepts are used in lexical analyser.
- To develop an understanding of finite automata through Turing machines.

Course Outcomes

Students will be able to:

- Understand the equivalence non deterministic finite automata and deterministic finite automata.
- Understand the equivalence between context free grammars and non-deterministic push down automata.
- Appreciate the power of the Turing machine as an abstract automaton that describes computation effectively and efficiently.
- To identify the undecidable problems.

Sr. No.	Course Outcome	PO
1.		PO1, PO4
2.		PO1, PO6, PO10
3.		PO2, PO6, PO8
4.		PO2, PO4, PO11
5.		PO3, PO7, PO8, PO12
6.		PO1, PO5, PO9
7.		PO2, PO6, PO9, PO11

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	√			√								
	√					√				√		
		√				√		√				
		√		√							√	
			√				√	√				√
	√				√				√			
		√					√		√			√

05 1X11 FORMAL LANGUAGES AND AUTOMATA THEORY

L–T–P : 3–0–0 Credit : 3

1. Introduction to Automata: Study and central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, application of finites automata, finite automata with epsilon transitions. Lecture: 3

2. Regular expression and Languages: Regular expression, finite automata and regular expressions, applications of regular expressions, algebraic law of regular expressions.

Lecture: 6

3. Properties of Regular Language: Proving languages not to be regular, closure properties of regular languages, equivalence and minimization of automata. Lecture: 4

4. Context-free Grammars and Languages: Parse trees, Applications of context free grammars, Ambiguity in grammars and languages. Lecture: 6

5. Pushdown Automata: Pushdown automata (PDA), the language of PDA, equivalence of PDA's and CFG's, deterministic pushdown automata. Lecture: 6

6. Properties of Context-Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages. Lecture: 5

7. Introduction to Turing Machine: Te Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing machines, Turing machines and Computers, Undecidable Problem about Turing machine, Post's Correspondence Problems.

Lecture: 7

8. Intractable Problem: The Classes P & NP, NP-Complete Problem, Example of P & NP Problem.

Lecture: 5

Text Book:

1. Introduction to Automata Theory, Languages, and Computation, 2e by John E, Hopcroft, Rajeev Motwani, Jeffery D. Ullman, Pearson Education.

2. Theory of Computer Science (Automata, Languages and Computation), 2e by K. L. P. Mishra and N. Chandrasekharan, PHI

Prof. Rajeev Kumar

DAY/TIME	09:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00
MONDAY	OOP (R: 33)				L U N C H	2:00-2:30 Weekly Test(IT/FLAT)	
TUESDAY	FLAT			ELII(Crypto)		OOP Lab(EE)	
WEDNESDAY		OOP				FIT Lab(ME+L	
THURSDAY	ELII(Crypto)	FIT Lab(EE)				OOP Lab(EE	
FRIDAY		FLAT		Mentoring 4th Week			
SATURDAY	ELII(Crypto)		FLAT				

Total Load: 8+12/2+1.5=15.5 Hrs.

Prof. In-charge, Time Table (Dept. of IT)

COURSE PLAN	
Semester	5th
Course Code	051x11
Course Credit	3
Course Name	FORMAL LANGUAGES AND AUTOMATA THEORY
Branches	Information Technology
Course Coordinator	***Rajeev kumar***
Date	03-08-2018

Part-A		Lecture Plan	
Sl. No.		Topic Name	Periods
1		**Introduction to Automata**	
	1.1	Basic concept of Automata Theory, Basic Terminology	2
	1.2	Deterministic and Non-Deterministic finite automata	4
	1.3	finite automata with epsilon transitions and application	2
2		**Regular expression and Languages**	
	2.1	Regular expression, finite automata and regular expressions	3
	2.2	applications of regular expressions, algebraic law of regular expressions	3
3		**Properties of Regular Language**	
	3.1	Proving languages not to be regular, closure properties of regular languages	2
	3.2	Equivalence and minimization of automata	2
4		**Context-free Grammars and Languages**	
	4.1	Parse trees, Applications of context free grammars	2
	4.2	Ambiguity in grammars and languages	2
5		**Pushdown Automata**	
	5.1	Pushdown automata (PDA)	2
	5.2	The language of PDA	1
	5.3	Equivalence of PDA's and CFG's,	2
	5.4	Deterministic pushdown automata	1
6		**Properties of Context-Free Languages**	
	6.1	Normal forms of context free grammar	1
	6.2	Pumping lemma for context free languages	1
	6.3	Closure properties of context free languages	2

7		**Introduction to Turing Machine**	
	7.1	Turing machine, programming techniques for Turing machine	**2**
	7.2	Extensions to the basic Turing machine, restricted Turing machines	**2**
	7.3	Turing machines and Computers, Undecidable Problem about Turing machine	**2**
	7.4	Post's Correspondence Problems.	**1**
8		**Intractable Problem**	
	8.1	The Classes P & NP, NP-Complete Problem	**2**
	8.1	Example of P & NP Problem	**1**
		TOTAL	**42**

PART B	Assignment Numbers	Topics
1	Assignment # 1	1
2	Assignment # 2	2
3	Assignment # 3	3
4	Assignment # 4	4

Text Books :

1. Introduction to Automata Theory, Languages, and Computation, 2e by John E, Hopcroft, Rajeev Motwani, Jeffery D. Ullman , Pearson Education.
2. Theory of Computer Science (Automata, Languages and Computation), 2e by K. L. P. Mishra and N. Chandrasekharan, PHI

Reference Books :

1. Finite Automata and Formal Languages: A Simple Approach ,A. M. Padma Reddy, Pearson Education India
2. An Introduction to FORMAL LANGUAGES and AUTOMATA(Fifth Edition), PETER LINZ

Institute / School Name :	Muzaffarpur Institute Of Technology, Muzaffarpur, Bihar		
Program Name	**IT B.Tech (5TH SEM)**		
Course Code	051X11		
Course Name	FLAT		
Lecture / Tutorial (per week):	3(3HR)	**Course Credits**	0
Course Coordinator Name	Assistant Professor Rajeev Kumar		

1. Scope and Objectives of the Course

- To present the theory of finite automata as the first step towards learning advanced topics such as compiler design.
- To discuss the applications of finite automata towards text processing.
- To develop an understanding of Regular expressions and context free grammars and how these concepts are used in lexical analyser.
- To develop an understanding of finite automata through Turing machines.

2. Evaluation Scheme:

Component 1*	Sessional Test (ST)*	20
Component 2	Assignment Evaluation	10
Component 3**	End Term Examination**	70
	Total	**100**

SYLLABUS

Topics	No of lectures	Weightage
Introduction to Automata: Study and central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, application of finites automata, finite automata with epsilon transitions.	3	7%
Regular expression and Languages: Regular expression, finite automata and regular expressions, applications of regular expressions, algebraic law of regular expressions	6	14%
Properties of Regular Language: Proving languages not to be regular, closure properties of regular languages, equivalence and minimization of automata.	4	10%
Context-free Grammars and Languages: Parse trees, Applications of context free grammars, Ambiguity in grammars and languages.	6	14%

Pushdown Automata: Pushdown automata (PDA), the language of PDA, equivalence of PDA's and CFG's, deterministic pushdown automata.	6	14%
Properties of Context-Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages.	5	12%
Introduction to Turing Machine: Te Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing machines, Turing machines and Computers, Undecidable Problem about Turing machine, Post's Correspondence Problems.	7	17%
Intractable Problem: The Classes P & NP, NP-Complete Problem, Example of P & NP Problem	5	12%

This Document is approved by:

Designation	**Name**	**Signature**
Course Coordinator	RAJEEV KUMAR	
H.O.D	VIJAY KUMAR	
PRINCIPAL		
Date		

Evaluation and Examination Blue Print:

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for the concerned examination. The components of evaluations along with their weightage followed by the University is given below

Sessional Test	20%
Internals	10%
End term examination	70%

Assignment 1

1. Explain symbol, alphabet, string and language.
2. Explain Application of FA
3. Difference between DFA, NFA and epsilon NFA.
4. Difference between Moore and Mealy machines.
5. Define Grammar and Types of Grammar.
6. Obtain a DFA that accepts strings of 0's and 1's starting with at least two 0's and ending with at least two 1's.
7. Draw a DFA to accept set of all strings on the alphabet $\Sigma = \{a, b\}$ that accepts language $L= (w, n_a(w) \geq 1. n_b(w)=2\}$
8. Draw a DFA to accept set of all strings on the alphabet $\Sigma = \{0, 1\}$ that either begins or ends both with substring 01.
9. Write the DFA for the following language over $\Sigma = \{a, b\}$

    a. $L= \{awa| w\varepsilon(a,b)^*\}$

    b. $L= \{w, |w| \bmod 3=0\}$

    c. $L= \{w |w| \bmod 5=0\}$

10. Give a DFA that accept the set of all strings beginning with 101.
11. Give DFA accepting the languages over alphabet {01} such that when interpreted as a binary integer is a multiple of 5 and begins with a 1.

Assignment 2

1. Obtain a NFA to accept the following over {0,1} the set of all strings that contain either 110 or 101.

2. Obtain a NFA to accept the following over {0,1} the set of all strings such that every 1 is immediately

followed by two 0's.

3. Convert the following NFA to DFA and informally describe the language it accepts.

	0	1
p	{p,q}	{p}
q	{r,s}	{t}
r	{p,r}	{t}
*s	ϕ	ϕ
*t	ϕ	ϕ

4. Prove that language L is accepted by some DFA if and only if L is accepted by some NFA.

5. Consider the following ε- NFA

	ε	a	b
p	{r}	{q}	{p,r}
q	ϕ	{p}	ϕ
*r	{p,q}	{r}	{p}

Compute the ε-closure of each state

b) Give the set of all strings if length 3 or less are accepted

c) Convert the automata to DFA

Assignment 3

1. Write regular expression for the language over {0,1}

i) Set of all strings with a even number of a's followed by odd number of b's

ii) L={w ε (0,1) : w has no pair of consecutive zeros}

iii) Set of strings of a's and b's of even length

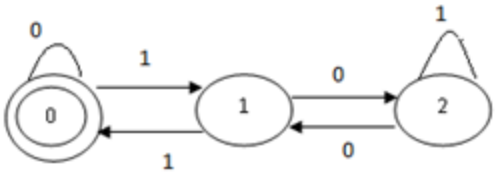
iv) Set of strings of a's and b's of odd length.

2. Consider the DFA

δ	0	1
q_1	q_2	q_1
q_2	q_2	q_3
q_3	q_3	q_2

Give Regular expression using Kleen's theorem.

3. Convert the following DFA to a regular expression using state elimination method.



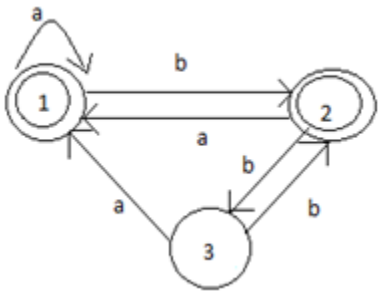
4. Convert the following regular expression to NFA with ε transitions.

a) 01+101

b) 011(0+1)*

c) (01+1)*

5. Consider the DFA below



a) Give regular expression for $R_{ij}^{(0)}$

b) Give regular expression for $R_{ij}^{(1)}$

c) Give regular expression for $R_{ij}^{(2)}$

d) Find $R_{11}^{3} + R_{12}^{3}$

Assignment-4

1. Give a Chomsky normal form and a Greibach normal form for the following grammar:

   $S \rightarrow AB$

   $A \rightarrow aAa \mid a$

   $B \rightarrow Bb \mid b$

2. If L_1 and L_2 are context free languages, then prove that family of context free languages are closed under union and concatenation.

3. Write context free grammar for the following languages.

a. $L=\{a^ib^jc^k: i+j=k, i>=0,j>=0\}$

b. $L=\{a^nb^mc^k:n+2m=k\}$

c. $L=\{a^ib^jc^k: i=j+k, i,j ,k>=0\}$

d. $L=\{0^{n+2}1^n:n\geq 1\}$

e. $L=\{w\varepsilon\{a\}^*||w|\text{mod } 3\neq|w|\text{mod } 2\}$

f. L={String of a's and b's with equal number of a's and b's}

g. L={Strings of a's and b's which are not palindromes}

4. Prove that the following grammar is ambiguous on string aab

S->aS|aSbS|ε

5. Show that the grammar below is ambiguous on the string aab

S->AB/aaB

A->Aa/a

B->b

6. Show that the following grammar is ambiguous

S->SbS

S->a

7. Consider the following grammar

E->+EE|*EE|-EE|x|y

Find left most derivation, right most derivation and parse tree for the string "+*-xyxy".

8. Consider the CFG with productions

E->E*T|T

T->F-T|F

F->(E)|0|1

Find left most derivation, right most derivation and parse tree for the string 0-((1*0)-0).

9. Prove that the following grammar is ambiguous, using the string "ibtibtaea".

S->iCtS| iCtSeS|a

C->b

Assignment 5

1. Design a PDA to accept the following language: L={$0^{2n}1^n$, n≥1} Draw the transition diagram for the constructed PDA. Also, show the moves made by PDA for the string "000011".

2. Design a PDA to accept the following language: L={WW^R |W ε (a+b)* and W^R is the reversal of W}. Write the ID for aabbaa.

3. Convert the following CFG to PDA and give the procedure for the same

S->aABB|aAA

A->aBB | a

B->bBB | A

C->a

4. Obtain PDA for the following Grammar

S->aSa/aa

S->bSb/bb

5. Convert the following CFG to PDA that accepts the language by empty stack.

E-> E+E|E*E|(E)|I

I->Ia|Ib|I1|a|b

6. Obtain a PDA Equivalent to the following grammar

S->AS|ε

A->0A1|A1|01

7. Write a short note on

    a) Recursive languages and halting problem.

    b) Post's correspondence problem.

8. Define Turing machine. Explain with a diagram, general structure and working of single tape, Turing machine.

Quality Measurement Sheets

a. Course End Survey

ACADEMIC YEAR:	SEM:	DATE:
COURSE:	CLASS:	FACULTY:

Please evaluate on the following scale:

Excellent(E)	Good(G)	Average(A)	Poor(P)	No Comment(NC)
5	4	3	2	1

SNO	QUESTIONAIRE	E 5	G 4	A 3	P 2	NC 1	Avg %
GENERAL OBJECTIVES:							
1	Did the course achieve its stated objectives?						
2	Have you acquired the stated skills?						
3	Whether the syllabus content is adequate to achieve the objectives?						
4	Whether the instructor has helped you in acquiring the stated skills?						
5	Whether the instructor has given real life applications of the course?						
6	Whether tests, assignments, projects and grading were fair?						
7	The instructional approach (es) used was (were) appropriate to the course.						
8	The instructor motivated me to do my best work.						
9	I gave my best effort in this course						
10	To what extent you feel the course outcomes have been achieved.						
Please provide written comments:							

a) What was the most effective part of this course

b) What are your suggestions, if any, for changes that would improve this course?

c) Given all that you learned as a result of this course, what do you consider to be most important?

d) Do you have any additional comments or clarifications to make regarding your responses to any particular survey item?

e) Do you have any additional comments or suggestions that go beyond issues addressed on this survey?

TEACHING EVALUATION

COLLEGE NAME

Department of Information Technology

Course Assessment

ACADEMIC YEAR:	SEM:	DATE:
COURSE:	CLASS:	FACULTY:

Assessment	Criteria Used	Attainment Level			Remarks
Direct (d)	Theory				
	External Marks				
	Internal Marks (Theory)				
	Assignments				
	Tutorials				
Indirect (id)	Course End Survey				
Theory: Course Assessment (0.6 × d+ 0.4 × id)					