# Institute Of Business & Information Technology
## University of the Punjab
**Quaid-e-Azam Campus, Lahore**

## Basic Information:

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|---|---|---|---|
| **Title:** | Theory of Automata | **Code** | IT 471 |
| **Program:** | BBIT (Major Information Technology) | **Credit Hours:** | Theory (03) |
| **Sessions:** | 30 Classes + Mid Term + Final Term | **Pre-Requisite:** | Data Structures & Algorithms |

## Course Description:

*The course introduces some fundamental concepts in automata theory and formal languages including grammar, finite automaton, regular expression, formal language, pushdown automaton, and Turing machine. Not only do they form basic models of computation, they are also the foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems, etc. The properties of these models will be studied and various rigorous techniques for analyzing and comparing them will be discussed, by using both formalism and examples.*

## Learning Outcomes:

*After the completion of this course, it is expected that students who will involve themselves in the knowledge base working of the course will be capable to*

✓ *Understand the concept of formal languages through such mechanism as regular expression, recursive definitions, finite automata, transition graph, Mealy machine and Moore machine.*
✓ *Apply Kleene's theorem and pumping lemma for the design and management of regular and non-regular languages.*
✓ *Construct context free, regular, Chomsky normal form grammars to design computer languages*
✓ *Design and construct a pushdown automaton and a Turing machine for a computer language*
✓ *Design and implement a parser for a computer language*

## Teaching Learning Methodology:

*The formal teaching component of this course consists of active student participation in and contribution to all forms of teaching and learning i.e. lectures, discussions, research assignments and projects. Lectures will be twice a week of 90 min each.*

## Group Configurations:

*One of the objectives of this course is to encourage and facilitate teamwork. Class will have to make a group of four for projects and research assignments. It is recommended that student will form their own groups. As a general guideline, your group should have members with diverse skill sets including people who are proficient or have aptitude for different subject areas.*

## Weekly Term Plan

| Wk | Lecture Topic |
|---|---|
| 01 | *Defining Language* |
| 02 | *Finite Automata* |
| 03 | *Transition Graph* |
| 04 | *Kleen Theorem* |
| 05 | *Non-Deterministic Automata* |
| 06 | *Moore Machine and Mealy Machine* |
| 07 | *Regular & Non-Regular Languages* |
| 08 | *Decidability* |
| 09 | *Mid Term Examination* |
| 10 | *Context Free Grammars* |
| 11 | *Context Free Languages* |
| 12 | *Push Down Automat* |
| 13 | *Decidability* |
| 14 | *Turing Theory* |
| 15 | *Computers* |
| 16 | *Final Term Examination* |

# Topics in Detail

**Languages**
*Introduction*
*Null String*
*Null Language*

**Defining Language**
*Kleene Closure*
*Regular Expression*
*Automata*

**Automata**
*Finite Automata*
*Definition*
*Transition Diagram*
*Languages of FA*
*Even Even*
*Transition Graph*
*Definition*
*Languages of TG*
*FA vs. TG*
*Non-Determinism*

**Kleene Theorem**
*Proof 1*
*FA to TG*
*TG to RE*
*RE to FA*
*Proof 2*
*Non-Deterministic Automata*

**Machines**
*Moore Machine*
*Mealy Machine*
*Comparison & Conversion*
*Transducer*

**Regular & Non-Regular Languages**
*Closure Properties*
*Complements & Intersection*
*Pumping Lemma*
*Quotient Languages*

**Decidability**
*Equivalence*
*Finiteness*

**Context Free Grammars**
*Definition*
*Trees*
*Lukasiewicz Notation*
*Ambiguity*
*Total Language Tree*

**Context Free Languages**
*Regular Grammars*
*Killing Λ & Unit Production*
*Chomsky Normal Form*
*Leftmost Definition*

**Push Down Automat**
*New Format of Finite Automata*
*Adding Stack to Finite Automata*
*Definition of PDA*
*CFG=PDA*
*Context Free and Non-Context Free Languages*

**Decidability**
*Emptiness & Uselessness*
*Finiteness*
*Parsing*

**Turing Theory**
*Turing Machines*
*Post Machine*
*Comparison*
*Minsky's Theorem*
*Neural Networks*

**Computers**
*Definition*
*Computable Functions*
*Church's Thesis*
*Language Generators*

| R e c o m m e n d e d   R e a d i n g s | T o o l s |
|---|---|
| A. *Introduction to Computer Theory* <br> *Danial Cohen* | 1. *Visio 4.5 Technical for Transition Diagrams* <br> 2. *Visual C++ for Programming* <br> 3. *Microsoft Word for Documentation* |
| B. *Introduction to Automata Theory & Computation* <br> *Jhon E. Hopcraft* | *Headings        Arial 11pt Bold* <br> *Normal Text    Times New Roman 10pt* <br> *Header Footer  Times New Roman 8pt* |
| C. *Introduction to Computer Theory* <br> *Marvin L. Minsky* | *Paragraph       Single Line Spacing* <br> *                 First Line Indent 1.0 cm* <br><br> *Page Margins    2 cm from each side* |

## Grading Policy:

*Final Grade for this course will be the cumulated result of the following term work with relevant participation according to the quoted percentage.*

| Sessional | 25% | | Mid Term | 35% | | Final Term | 40% |
|---|---|---|---|---|---|---|---|
| *Assignments* | 10 % | | *Mid Term Exam* | 25% | | *Final Exam* | 30% |
| *Quizzes* | 10% | | *Lab Work/ Lab Mid Exam* | 10% | | *Case Study/ Project/ Term Paper* | 10% |
| *Presentations* | 05% | | | | | | |

*Remember subdivision of Mid Term and Final Term Examination should be done only in case of very essential and major Grading Instruments.*

## Dishonest Practices & Plagiarism

*A student found responsible for dishonest practice/cheating (copying the work of others, use of unauthorized material in Grading Instruments etc.) in relation to any piece of Grading Instrument will face penalties like deduction of marks, grade 'F' in the course, or in extreme cases, suspension and rustication from IBIT. For details consult Plagiarism Policy of the PU at http://pu.edu.pk/dpcc/downloads/Plagiarism-Policy.pdf*

## Grading System:

| Letter Grade | Grade Point | Num Equivalence |
|---|---|---|
| A | 4.00 | 85 – 100 % |
| A- | 3.70 | 80 – 84 % |
| B+ | 3.30 | 75 – 79% |
| B | 3.00 | 70 – 74 % |
| B- | 2.70 | 65 – 69 % |
| C+ | 2.30 | 61 – 64 % |
| C | 2.00 | 58 – 60 % |
| C- | 1.70 | 55 – 57 % |
| D | 1.00 | 50 – 54 % |
| F | 0.00 | Below 50 % |
| I | Incomplete | * |
| W | Withdraw | * |

## Norms to Course:

- ✓ *Submission Date and Time for the term instruments is always* **Un-Extendable**
- ✓ *7 Absentees in class will be result in forced withdrawal. (**PU Policy**)*
- ✓ *Re-sit in Mid and Final Term will cause you a loss of 2 and 3 grade marks respectively. (**PU Policy**)*
- ✓ *This is your responsibility to keep track of your position in class evaluation units.*
- ✓ *After the submission date, NO excuse will be entertained.*
- ✓ ***Keep a copy of all submitted Grading Instruments.***
- ✓ *Assignment is acceptable only in its Entirety.*
- ✓ *No make up for any assignment and quiz.*
- ✓ *Copied & Shared work will score Zero.*
- ✓ *Assignments are Individual.*

# Good Luck