

# King Fahd University of Petroleum and Minerals

Department of Information and Computer Science

## ICS 355 - Theory of Computing

Section: 01 – Term: 171



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**COURSE SITE:** [almuhamadi.com/sultan/ics355](http://almuhamadi.com/sultan/ics355) and Blackboard

### DESCRIPTION

Regular Grammars: equivalence of DFA, NFA and regular expressions, pumping lemma, emptiness and membership. Context-Free Grammars: parsing and ambiguity, normal forms, applications, equivalence of PDA's and CFG's, pumping lemma, emptiness and membership. Turing Machine: programming techniques for Turing machines, equivalence of one-tape and multitape TM's, universal Turing-machine. Undecidability: recursively enumerable and recursive languages, undecidability, problem reduction, undecidable problems of CFG's, RE's and TM's.

**PREREQUISITES** ICS 253/254

### COURSE OBJECTIVES

1. To introduce powerful language's notations: DFAs, NFAs, and regular expressions, grammars, PDAs, and Turing machines.
2. To determine and prove a language's location in the Chomsky hierarchy (regular, context-free, context-sensitive, and recursively enumerable languages).
3. To explain the Turing thesis and its significance, and gain a general exposition to the theory of decidability.

### COURSE LEARNING OUTCOMES

After completion of this course, the student shall be able to:

1. Design and explain regular languages in different notations: DFA, NFA, regular expressions and grammars, and convert between these notations.
2. Use the pumping lemma to prove that a given language is not regular.
3. Understand pushdown automata, context-free grammars, and their normal forms, and apply CYK algorithm on context-free languages.
4. Understand the Chomsky hierarchy for language classification, and determine the class of a given language and the type of a given grammar.
5. Understand the Turing thesis and its implications, and explain basic concepts of the theory of decidability.

### TEXTBOOK

P. Linz, An Introduction to Formal Languages and Automata, Jones and Bartlett Publishers.

## EVALUATION

Coursework and homework assignments	25%
Major Exam I	20%
Major Exam II	25%
Final Exam	30%

## CONTENTS

The following schedule is tentative and subjected to changes. Any change will be announced in the class and course website/ WebCT.

1. Introduction to alphabet, languages, and regular expressions.
2. Regular Languages. Finite-state automata, DFA and NFA.
3. Equivalence of DFA, NFA and regular expression.
4. Pigeon-hole principle, pumping lemma, and non-regular languages.
5. Grammar, Context-Free and Context-Sensitive Grammar.
6. Context-Free Languages and Pushdown Automata.
7. Turing Machines. Recursive and Recursively enumerable languages. Linear bounded automata.
8. Hierarchy of Formal Languages and the Chomsky Hierarchy.
9. Undecidability, the Halting Problem, Hilbert 10th Problem. Reducibility and Rice's Theorem.
10. Gödel Incompleteness Theorem and Computational Complexity (If time permits).

## Course Policies

- **Coursework includes** participation, online/in-class discussions and activities, attendance, homework assignments, and quizzes. Active learning is implemented in this class. Students are expected to be positively engaged in the learning process.
- **Course Website & Participation:** Students are required to periodically check the course website and download course material as needed.
  - Several resources will be posted through the website as well.
  - [Blackboard](#) will be used for communication and interaction, posting and submitting assignments, posting grades, posting sample exams, etc.
  - It is expected that you get benefit of the discussion board by raising questions or answering questions put by others.
- **Attendance:** Regular attendance is a university requirement.
  - Attendance will be checked at each lecture.
  - Missing 20% of the classes will result in an automatic DN grade (without warning).
  - Late arrivals will disrupt the class session, and may be counted as a miss if repeated.
  - If you find yourself unable to attend a class, email the instructor ahead of time for better planning and management of the class. If you fail to do so, send your email as soon as you get a chance and provide your excuses if any.
  - Every unexcused absence may lead to a loss of 0.5% of total grade.
- **Late assignments:** are subjected to late-penalty. See late submission policy on the course website/ Blackboard under the Assignments page.
- **Re-grading policy:** If you have a complaint about any of your grades, discuss it with the instructor no later than 3 days of distributing the grades (except for the final). Only legitimate concerns on grading should be discussed.

- ***Office Hours:***
  - Students are encouraged to use the office hours to clarify any part of the material that is not clear. Use the Blackboard (Bb) for quick points and homework questions.
  - For urgent issues, use emails instead of Bb-mails, please indicate ICS454 in the "Subject" field of your email (e.g. ICS454: Quiz1 score is missing).
- ***Academic honesty:***
  - Students are expected to abide by all the university regulations on academic honesty.
  - Cheating will be reported to the Department Chairman.
  - Although collaboration and sharing knowledge is highly encouraged, copying others' work without proper citation, either in part or full, is considered plagiarism. Whenever in doubt, review the university guidelines or consult the instructor.
- ***Courtesy:***
  - Students are expected to be courteous toward their classmates and the instructor throughout the duration of this course (in-class and online).
  - Side-talks and text-messages during the class are prohibited.