

Academic Year: ( 2024 / 2025 )

Review date: 26-04-2024

Department assigned to the subject: Computer Science and Engineering Department

Coordinating teacher: SANCHIS DE MIGUEL, MARIA ARACELI

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Programming  
Algorithms and Data Structures

## OBJECTIVES

The objective of this course is for the student to acquire the following competencies and learning outcomes:

### 1.- General and Basic Competencies:

CGB3 - Ability to understand and master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and their application to solve engineering problems.

CGO9 - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Technical Engineer in Computer Science.

CB1 - That the students have demonstrated to possess and understand knowledge in an area of study that starts from the basis of general secondary education, and is usually at a level that, although it is supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

CB3 - That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant social, scientific or ethical issues.

CB5 - That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

### 2. Specific competences:

CECRI5 - Knowledge, administration and maintenance of computer systems, services and applications.

CECRI6 - Knowledge and application of the basic algorithmic procedures of computer technologies to design solutions to problems, analyzing the suitability and complexity of the proposed algorithms.

CECRI15 - Knowledge and application of the fundamental principles and basic techniques of intelligent systems and their practical application.

### 3. Learning outcomes:

R1 Knowledge and understanding: have basic knowledge and understanding of the scientific and technological foundations of Computer Engineering, as well as a specific knowledge of computer science, computer engineering and information systems.

R5 Engineering Applications: Graduates will be able to apply their knowledge and understanding to solve problems, conduct research, and design devices or processes in the field of Computer Engineering according to criteria of cost, quality, safety, efficiency, environmental friendliness, and ethical implications. These skills include knowledge, use and limitations of computer systems, process engineering, computer architectures, computational models, equipment, practical work, technical literature and information sources.

## DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to the theory of automata and formal languages.
  - 1.1. Why study Automata Theory. History and Origins
  - 1.2. Relationship with others Areas of Knowledge
  - 1.3. Machines, Languages and Algorithms.
  
- 2.- Automata Theory
  - 2.1 Introduction and Definitions.
  - 2.2 Mathematical model of an automaton
  - 2.3 Automata and algorithms.
  - 2.4 Discrete, continuous, and hybrid automata. Classes of automata.
  
3. Finite Automata
  - 3.1 Definition and Representation of Deterministic Finite Automata (DFA)
  - 3.2. DFA as Recognition Device
  - 3.3. Equivalence and Minimization of DFA
  - 3.4. Theorems of DFA
  - 3.5. Definition and Representation of Nondeterministic Finite Automata (NFA)
  - 3.6. The Language of a NFA
  - 3.7. Equivalence of DFA and NFA
  
4. Languages and Formal Grammars.
  - 4.1. Operations with Words. Operations with Languages. Derivations.
  - 4.2 Concept of Grammar. Formal Grammar.
  - 4.3. Chomsky Hierarchy and Equivalent Grammar
  - 4.4 Context-Free Grammar
  - 4.5. Language of a Context-Free Grammar. Parse Tree
  - 4.6. Well-Formed Grammar
  - 4.7. Chomsky Normal Form. Greibach Normal Form
  
5. Regular Languages.
  - 5.1. Definition of Regular Languages
  - 5.2. DFA for a Regular Grammar
  - 5.3. Equivalence of Regular Expressions
  - 5.4. Kleene's Theorem
  - 5.5. Characteristic equations
  - 5.6. Synthesis Problem: Recursive Algorithm
  - 5.7. Derivatives of Regular Expressions
  
6. Pushdown Automata.
  - 6.1. Definition of Pushdown Automata (PDA).
  - 6.2. Transitions, Movement and Instantaneous Description in PDA.
  - 6.3. Acceptance by Empty Stack. Acceptance by Final State.
  - 6.4. Language Accepted by a PDA.
    - Equivalence of PDA by Empty Stack and PDA by Final State.
  - 6.5. From Context-Free Grammar to Push-Down Automata.
  - 6.6. From Pushdown Automata to Context-Free Grammar.
  
7. Turing Machine.
  - 7.1. Definition of Turing Machine.
  - 7.2. Variations of Turing Machine.
  - 7.3. Universal Turing Machine.
  
8. Computational Complexity
  - 8.1. Complexity Theory
  - 8.2. Complexity of algorithms
  - 8.3. P versus NP problems
  - 8.4 Defining complexity classes
  - 8.5 Time complexity
  - 8.6 Hierarchy theorems
  - 8.7 Non-computational problems
  - 8.9 Limits of Computability

**THEORETICAL-PRACTICAL CLASSES (theoretical content): 3.5 ECTS.**

The knowledge to be acquired by the students will be presented. They will receive the class notes and will have basic reference texts to facilitate the follow-up of the classes and the development of the subsequent work. Exercises will be solved by the student that will serve as self-evaluation and to acquire the necessary skills. Classes of problems, in which the problems proposed to the students will be developed and discussed.

**WORKSHOPS AND/OR LABORATORY PRACTICES. 1.5 ECTS.**

Developed with or without the presence of the teacher, they aim to complete and integrate the development of all the specific and transversal competences, in the resolution of two practical cases where the approach to the problem, the choice of the resolution method, the results obtained and their interpretation are well documented.

**FINAL EXAM. 0,5 ECTS**

The knowledge, skills and abilities acquired throughout the course will be globally assessed.

**TUTORIALS. 0,5 ECTS**

Individualized assistance (individual tutorials) or in group (collective tutorials) to the students by the professor.

## ASSESSMENT SYSTEM

**% end-of-term-examination:** 50

**% of continuous assessment (assignments, laboratory, practicals...):** 50

The assessment will consist of several continuous assessment activities and a final test.

The aim of continuous assessment is to help students monitor their progress in the learning process, receiving continuous feedback on the degree of assimilation of competences during the course. Thus, each partial test and the practical work will be both a learning and an assessment activity.

The final test aims to establish the degree of assimilation, the degree of acquisition of cognitive and procedural competences.

Continuous assessment will account for 50% of the final mark for the subject and will consist of:

- Two or three written tests (test questions, short questions and problem solving),
- Four practical assignments using the JFLAP tool (<http://www.cs.duke.edu/csed/jflap/>).

If two written tests are taken, each one will account for 18% of the mark for the subject. If three written tests are taken, each one will account for 12% of the mark. Practical work will account for 14% of the course grade.

The final exam (50% of the final mark for the course) will consist of theoretical questions, exercises and practical problems.

The mark obtained through continuous assessment will only be added if a mark of 4 or more is obtained in the final exam.

## BASIC BIBLIOGRAPHY

- Enrique Alfonseca Cubero, Manuel Alfonseca Cubero, Roberto Moriyón Salomón. Teoría de autómatas y lenguajes formales., McGraw-Hill, 2007
- John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman. Introduction to Automata Theory, Languages, and Computation (Third Edition), Pearson Education, Pearson Addison Wesley.
- Manuel Alfonseca, Justo Sancho, Miguel Martínez Orga. Teoría de lenguajes, gramáticas y autómatas., Publicaciones R.A.E.C. ISBN: 8460560929. , 1997.
- Pedro Isasi, Paloma Martínez y Daniel Borrajo. Lenguajes, Gramáticas y Autómatas. Un enfoque práctico., Addison-Wesley, 1997

