Advanced Computation Theory

Academic Year: (2022 / 2023) **Review date: 09-06-2022**

Department assigned to the subject: Computer Science and Engineering Department

Coordinating teacher: ALONSO WEBER, JUAN MANUEL

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Discrete Mathematics (Course 1 - Semester 2)
Theory of Automata and Formal Languages (Course 2 - Semester 1)

DESCRIPTION OF CONTENTS: PROGRAMME

Relevant contents:
1.- Cost of computational processes
2.- Recursive algorithms complexity
3.- Introduction to computability theory
4.- Introduction to computational complexity theory
5.- Spatial complexity
6.- Kolmogorov complexity
7.- Computation models
8.- Probabilistic algorithms

Programme:
1. Computational Cost of Algorithms.
 1.1 Computational Complexity and Computational Cost.
 1.2 Computational Cost of Structured Programs
 1.3 Computational Cost of Recursive Programs
 1.4 Probabilistic Analysis

2. Introduction to Computability Theory
 2.1 Definition of Problem. Decision Problems
 2.2 Turing Machines and Decidability
 2.3 Computability and Decidability

3. Introduction to Complexity Theory
 3.1 Problem Reduction
 3.2 Classes P, NP and NP-Complete.
 3.3 Classes PSpace, NPSpace.
 3.3 Classes NP-Hard, Exp, CoP, CoNP

4. Models of Computation
 4.1 Turing Machines (Multi-tape, Non deterministic)
 4.2 Cellular Automata
 4.3 Lindenmayer Systems

LEARNING ACTIVITIES AND METHODOLOGY

THEORETICAL-PRACTICAL CLASSES. [44 hours with 100% classroom instruction, 1.67 ECTS]
Knowledge and concepts students must acquire. Student receive course notes and will have basic reference texts to facilitate following the classes and carrying out follow up work. Students partake in exercises to resolve practical problems and participate in workshops and evaluation tests, all geared towards acquiring the necessary capabilities.

TUTORING SESSIONS. [4 hours of tutoring with 100% on-site attendance, 0.15 ECTS]
Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.

STUDENT INDIVIDUAL WORK OR GROUP WORK [98 hours with 0 % on-site, 3.72 ECTS]

WORKSHOPS AND LABORATORY SESSIONS [8 hours with 100% on site, 0.3 ECTS]

FINAL EXAM. [4 hours with 100% on site, 0.15 ECTS]
Global assessment of knowledge, skills and capacities acquired throughout the course.

METHODOLOGIES

THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject's main concepts are developed, while providing material and bibliography to complement student learning.

PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group.

TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with a teacher as tutor.

LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

SE1 - FINAL EXAM. [35 %]
Global assessment of knowledge, skills and capacities acquired throughout the course.

SE2 - CONTINUOUS EVALUATION. [65 %]
Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.

The continuous assessment mark will be determined based on:
- Mid term exam: 33%
- Practical exercises: 67%

A minimum mark for the final-term exam (4 out of 10) is required to pass the subject.

% end-of-term-examination:	35
% of continuous assessment (assigments, laboratory, practicals…):	65

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, Addison-Wesley 3rd Edition.
- John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman Introducción a la teoría de autómatas, lenguajes y computación, Addison-Wesley, 2007
- Michael Sipser Introduction to the Theory of Computation. 2nd ed., Boston, MA: Course Technology, 2005
- Michael Sipser Introduction to the Theory of Computation. 3d ed., Boston, MA: Course Technology, 2013
- S. Wolfram Cellular Automata and Complexity, Addison-Wesley, 1996

ADDITIONAL BIBLIOGRAPHY

- C. Papadimitriou Computational Complexity, Addison-Wesley, 1995
- C. Papadimitriou, K. Steiglitz Combinatorial Optimization, Dover, 1998
- H. S. Wilf Algorithms and Complexity, Prentice-Hall, 1986
- Jeffrey Shallit A Second Course in Formal Languages and Automata Theory, Cambridge University Press, 2008
- S. Wolfram A New Kind of Science, Wolfram Media, 2003