



DEGREE CURRICULUM  
**COMPUTATIONAL LOGIC**

Coordination: MARTÍNEZ RODRÍGUEZ, SANTIAGO

Academic year 2020-21

## Subject's general information

<b>Subject name</b>	COMPUTATIONAL LOGIC			
<b>Code</b>	102366			
<b>Semester</b>	1st Q(SEMESTER) CONTINUED EVALUATION			
<b>Typology</b>	<b>Degree</b>	<b>Course</b>	<b>Character</b>	<b>Modality</b>
	Bachelor's degree in Digital Interaction and Computing Techniques	1	COMMON	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	PRALAB	TEORIA	
	<b>Number of credits</b>	3	3	
	<b>Number of groups</b>	1	1	
<b>Coordination</b>	MARTÍNEZ RODRÍGUEZ, SANTIAGO			
<b>Department</b>	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING			
<b>Teaching load distribution between lectures and independent student work</b>	6 ECTS = 25x6 = 150 working hours: 40% -> 60 blended learning hours, 60% -> 90 autonomous work hours.			
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.			
<b>Language</b>	Catalan.			
<b>Distribution of credits</b>	Synchronous virtual theory: 1.5 Asynchronous virtual theory: 1.5 Practices: 3			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
MARTÍNEZ RODRÍGUEZ, SANTIAGO	santi.martinez@udl.cat	6	

## Subject's extra information

To address this subject, properly skills on analysis and logical reasoning are recommended.

For any question, please, send an email to the teacher.

## Learning objectives

At the end of the course, the student will be able to:

- Model sentences in propositional logic.
- Reason about the validity of propositional logic formulas.
- Apply systems of automatic reasoning to propositional logic formulas.
- Model sentences in first order logic.
- Reason about the validity of first order logic formulas.
- Apply systems of automatic reasoning to first order logic formulas.

## Competences

### Basic Competences

- **B01.** That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge coming from the vanguard of his/her field of study.

### Transversal Competences

- **CT3.** Acquire training in the use of new technologies and information and communication technologies.
- **CT5.** Acquire essential notions of scientific thought.

### General Competences

- **CG2.** Design, develop, evaluate and guarantee the accessibility, ergonomics, usability and security of computer systems.
- **CG3.** Use adequate hardware and software platforms to develop and execute interactive digital applications.
- **CG5.** Know the basic subject areas and technologies needed to learn and develop new methods and technologies, and those that help to adapt to new situations.
- **CG7.** Solve problems through initiative, determination, independence and creativity.
- **CG8.** Capacity for abstraction and critical, logical and mathematical reasoning.

### Specific Competences

- **CE2.** Capacity to understand and master the basic concepts of discrete mathematics, logics, algorithmic and computational complexity, and its application to solve computational problems.
- **CE3.** Basic knowledge of the use and programming of computers, operating systems and databases, and their use in the development of interactive applications.
- **CE4.** Capacity to know, understand and evaluate the structure and architecture of computers, as well as the basic components that conform them.
- **CE16.** Capacity to design and evaluate person-computer interfaces that guarantee the usability of systems, services and computer applications.
- **CE17.** Capacity to apply knowledge on design to propose and defend a design concept for an interactive system and use proper creative technologies to develop each project.
- **CE24.** Capacity to understand the human factors involved in any interactive process between humans and technology, as well as being able to adequately apply them in the design of interactive products and services, and their interfaces.

## Subject contents

The contents of the subject are the following:

Unit 1: Introduction to Logic Systems and Automated Reasoning

Unit 2: Propositional Logic

Unit 3: First Order Logic

Unit 4: Logic Programming

### Unit 2: Propositional Logic

- Syntax, Semantics and Truth Tables
- Taxonomy of Sentences (satisfiable, unsatisfiable and tautology)
- Logic Equivalence, Equisatisfiability and Logic Consequence
- Modelling Sentences
- Normal Forms: Translations into Clausal Form
- Resolution Principle
- Automated Reasoning to Prove Validity of Formulas

### Unit 3: First Order Logic

- Syntax and Semantics
- Taxonomy of Sentences (satisfiable, unsatisfiable and tautology)
- Logic Equivalence
- Modelling Sentences
- Substitution, Composition of Substitutions and Application of Substitutions to Expressions
- Unification of Expressions and Most General Unifier
- Normal Forms: Translations into Clausal Form
- Resolution Principle
- Automated Reasoning to Prove Validity of Formulas

### Unit 4: Logic Programming

- Logic Programs
- SLD Resolution

## Methodology

The course contents are divided into two blocks. The first block presents the logical system of propositional logic. The second presents the logical system of logic predicates. For each logical system we study: the syntax and semantics of the language and the proof procedure based on resolution. Additionally, for each system we study how to model problems and use state-of-the-art tools for solving them. In this sense, for propositional logic we use a SAT solver.

For each block we propose a collection of problems that student must solve independently. This work is supervised during the Large Group and Medium Group sessions.

Each week students attend 2 virtual hours (1 synchronous and 1 asynchronous) with a Large Group and 2 hours with a Medium Group. Synchronous virtual sessions are videoconferences, asynchronous sessions are videos. Medium Group sessions are practices.

## Development plan

Week	Description	Large Group Activity	Medium Group Activity	Autonomous Work
1	Introduction to Logic Systems	U1: Introduction to Logic Systems	Introduction to Logic Systems	Bibliography and Linux tutorial
2	Syntax, Semantics and Truth Tables	U2: Propositional Logic	Linux tutorial, SAT solvers Description Activity 1	Linux tutorial, SAT solvers
3	Classification of statements and Modeling	U2: Propositional Logic	Exercices Unit 2	Activity 1 Exercices Unit 2
4	Normal Forms	U2: Propositional Logic	Activity 1	Activity 1 Exercices Unit 2

Week	Description	Large Group Activity	Medium Group Activity	Autonomous Work
5	Resolution principle	U2: Propositional Logic	Exercices Unit 2	Activity 1 Exercices Unit 2
6	Automated proof	U2: Propositional Logic	Exercices Unit 2	Activity 1 Exercices Unit 2
7	Automated proof	U2: Propositional Logic	Activity 1 Exercices Unit 2	Activity 1 Exercices Unit 2
8	Syntax and Semantics	U3: First Order Logic	<b>Deliverable Activity 1</b> Doubts on Units 1 and 2	Exercices Unit 2
9		<b>1st Midterm Exam</b>		Study
10	Classification of statements and Modeling	U3: First Order Logic	Description Activity 2 Exercices Unit 3	Activity 2 Exercices Unit 3
11	Substitution and Unification	U3: First Order Logic	Activity 2	Activity 2 Exercices Unit 3
12	Normal Forms	U3: First Order Logic	Activity 2 Exercices Unit 3	Activity 2 Exercices Unit 3
13	Resolution principle	U3: First Order Logic	Exercices Unit 3	Activity 2 Exercices Unit 3
14	Logic Programs	U4: Logic Programming	Activity 2 Exercices Unit 4	Activity 2 Exercices Unit 4
15	SLD resolution	U4: Logic Programming	Doubts on Units 3 and 4	Exercices Unit 4
16		<b>2nd Midterm Exam</b>	<b>Deliverable Activity 2</b>	Study
17		<b>2nd Midterm Exam</b>		Study
18				
19		<b>Improvement Exam</b>		Study

## Evaluation

### Evaluation activities

Acronym	Evaluation Activity	Weight	Minimum Score	Group	Compulsory	Recoverable
EP1	1st Midterm Exam	35%	No	No	Yes	Yes
EP2	2nd Midterm Exam	35%	No	No	Yes	Yes
PR1	Activity 1	15%	No	Yes ( $\leq 2$ )	Yes	No
PR2	Activity 2	15%	No	Yes ( $\leq 2$ )	Yes	No
PCL	Participation in class	0.5 points	No	No	No	No
<b>Final Score = 0.35 · EP1 + 0.35 · EP2 + 0.15 · PR1 + 0.15 · PR2 + PCL</b>						

If confinement prevents from doing an exam in person, it will be replaced by a test (via campus virtual) and an individual exercise.

### Recovery of midterm exams 1 and 2:

If the final score  $< 5$ , the student can recover/improve these exams (the student can choose one exam or both).

### Midterm Exam 1: Propositional logic

Objectives:

- Model sentences in propositional logic.
- Reason about the validity of propositional logic formulas.
- Apply systems of automatic reasoning to propositional logic formulas.

Criteria:

The exam will be evaluated over 10 points. Its weight is 35% of the final score. It may be improved in the recovery period.

### Compulsory Activity 1: Propositional logic

Objectives:

- Use a SAT solver.
- Model sentences as logic formulas.
- Reason about the validity of logic formulas.
- Automate proof systems.
- Reason about proof systems.
- Apply proof systems.
- Apply automated reasoning logic systems of propositional logic to mathematical and computer science problems.

Criteria:

The activity will be evaluated over 10 points. Its weight is 15% of the final score. It can not be recovered.

### Midterm Exam 2: First Order Logic

Objectives:

- Model sentences in first order logic.
- Reason about the validity of first order logic formulas.
- Apply systems of automatic reasoning to first order logic formulas.

Criteria:

The exam will be evaluated over 10 points. Its weight is 35% of the final score. It may be improved in the recovery period.

### Compulsory Activity 2: First Order Logic

Objectives:

- Model sentences as logic formulas.
- Reason about the validity of logic formulas.

Criteria:

The activity will be evaluated over 10 points. Its weight is 15% of the final score. It can not be recovered.

## Bibliography

### Basic

- Teresa Hortalá, Narciso Martí, Miguel Palomino, Mario Rodríguez, Rafael del Vado: *Lógica matemática para informáticos*. Pearson, Prentice Hall, 2008.
- Enrique Paniagua, Juan Luís Sánchez, Fernando Martín: *Lógica computacional*. Thomson-Paraninfo, 2003.
- John Wylie Lloyd: *Foundations of Logic Programming*. Springer-Verlag, second edition, 1987.

### Complementary

- Jean H. Gallier: *Logic for Computer Science: Foundations of Automatic Theorem Proving*, 2003 (<http://www.cis.upenn.edu/~jean/gbooks/logic.html>).
- Uwe Schöning: *Logic for Computer Scientists*. Birkhäuser, Boston, 1989.
- Tom Tymoczko, Jim Henle: *Razón, dulce razón: Una Guía de Campo de la Lógica Moderna*. Ariel, 2002.