



## Teaching Guide

| Teaching Guide      |                                                                                                        |        |          |                      |
|---------------------|--------------------------------------------------------------------------------------------------------|--------|----------|----------------------|
| Identifying Data    |                                                                                                        |        |          | 2023/24              |
| Subject (*)         | Programming Language Design                                                                            |        | Code     | 614G01065            |
| Study programme     | Grao en Enxeñaría Informática                                                                          |        |          |                      |
| Descriptors         |                                                                                                        |        |          |                      |
| Cycle               | Period                                                                                                 | Year   | Type     | Credits              |
| Graduate            | 1st four-month period                                                                                  | Fourth | Optional | 6                    |
| Language            | Spanish                                                                                                |        |          |                      |
| Teaching method     | Face-to-face                                                                                           |        |          |                      |
| Prerequisites       |                                                                                                        |        |          |                      |
| Department          | Ciencias da Computación e Tecnoloxías da InformaciónComputación                                        |        |          |                      |
| Coordinador         | Alonso Pardo, Miguel angel                                                                             |        | E-mail   | miguel.alonso@udc.es |
| Lecturers           | Alonso Pardo, Miguel angel                                                                             |        | E-mail   | miguel.alonso@udc.es |
|                     | Graña Gil, Jorge                                                                                       |        |          | jorge.grana@udc.es   |
|                     | Roca Rodríguez, Diego                                                                                  |        |          | d.roca1@udc.es       |
| Web                 | campusvirtual.udc.es                                                                                   |        |          |                      |
| General description | This course deals with the following aspects of the specification and design of programming languages: |        |          |                      |
|                     | * Design Criteria for control structures and datat ypes.                                               |        |          |                      |
|                     | * Design of object-oriented programming languages.                                                     |        |          |                      |
|                     | * Models for the formal definition of the semantics of programming languages                           |        |          |                      |
|                     | * Formal specification of type systems. Subtyping relations                                            |        |          |                      |
|                     | * Computability. Analysis of complexity and its relation to the design of programming languages.       |        |          |                      |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                               |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A39  | Capacidade para ter un coñecemento profundo dos principios fundamentais e modelos da computación, e saber aplicalos para interpretar, seleccionar, valorar, modelar, e crear novos conceptos, teorías, usos e desenvolvementos tecnolóxicos relacionados coa informática. |
| A40  | Capacidade para coñecer os fundamentos teóricos das linguaxes de programación e as técnicas de procesamento léxico, sintáctico e semántico asociadas, e saber aplicalas para a creación, o deseño e o procesamento de linguaxes.                                          |
| B1   | Capacidade de resolución de problemas                                                                                                                                                                                                                                     |
| C2   | Dominar a expresión e a comprensión de forma oral e escrita dun idioma estranxeiro.                                                                                                                                                                                       |
| C6   | Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                                                                         |

## Learning outcomes

| Learning outcomes                                                                                                                                        | Study programme competences |    |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----|----------|
| To introduce lambda-calculus, typed and untyped, as the fundamental core of programming languages.                                                       | A39<br>A40                  | B1 | C2<br>C6 |
| To understand the formal base of typing and subtyping systems                                                                                            | A39<br>A40                  | B1 | C2<br>C6 |
| To understand and master the design principles of object-oriented languages and the implications that design choices have on the development of programs | A39<br>A40                  | B1 | C6       |
| To manage the design principles of the main control structures of programming languages and their implications for program development                   | A39<br>A40                  | B1 | C6       |
| To manage the design principles of the main data structures of programming languages and their implications for program development                      | A39<br>A40                  | B1 | C6       |

## Contents



| Topic                                     | Sub-topic                                                                                                                     |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Formal definition of type systems         | Operational, denotational and axiomatic semantics<br>An introduction to lambda-calculus<br>Typed lambda-calculus<br>Subtyping |
| Object-Oriented Languages                 | Fundamental concepts of object-oriented languages<br>Type problems in object-oriented languages                               |
| Principles of Programming Language Design | Names, scopes and binding<br>Control flow<br>Data types<br>Subroutines                                                        |
| Computability and Complexity              | Computability and Lambda calculus<br>Complexity classes                                                                       |

| Planning                                                                                                                        |              |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies | Ordinary class hours | Student's personal work hours | Total hours |
| Laboratory practice                                                                                                             | A39 C2 C6    | 14                   | 42                            | 56          |
| Workshop                                                                                                                        | B1 C6        | 7                    | 14                            | 21          |
| Objective test                                                                                                                  | A40 B1       | 2                    | 6                             | 8           |
| Guest lecture / keynote speech                                                                                                  | A40 C2       | 21                   | 42                            | 63          |
| Personalized attention                                                                                                          |              | 2                    | 0                             | 2           |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |              |                      |                               |             |

| Methodologies                  |                                                                                                                                                                                              |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                                                  |
| Laboratory practice            | Activity that allows students to learn effectively through the realization of practical activities, in this case lab assignments, demonstrations and exercises.                              |
| Workshop                       | They are made to complement all other activities, in some cases solved independently by the student and sometimes under the supervision of the professor.                                    |
| Objective test                 | Test in which the knowledge acquired in the theoretical and practical parts of the subject will be assessed.                                                                                 |
| Guest lecture / keynote speech | Oral presentation complemented with the use of audiovisual media and the formulation of questions to/by the students, with the aim of transmitting knowledge and stimulate critical thinking |

| Personalized attention          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Workshop<br>Laboratory practice | Lectures, problem-solving sessions and practical sessions will be developed in response to student progress in understanding and assimilation of the contents. Overall progress will be made compatible with specific attention to those students who have more difficulties in the learning task and with additional support to those that present greater ease and wish to increase their knowledge.<br><br>Individual tutoring should not be used to extend the contents with new concepts, but to clarify the concepts already discussed in class. The teacher will use them as an interaction that allows him to draw conclusions about the degree of assimilation of the subject by students. |

| Assessment          |              |                       |               |
|---------------------|--------------|-----------------------|---------------|
| Methodologies       | Competencies | Description           | Qualification |
| Objective test      | A40 B1       | Written exam          | 50            |
| Laboratory practice | A39 C2 C6    | Practical assignments | 50            |



## Assessment comments

The theoretical part of the course computes 50% of the grade.

The remaining 50% is divided between lab assignments and any other evaluation activities performed throughout the course. If the lab assignments or other activities are carried out in groups, all members of the group will be jointly liable for the work carried out and delivered and its consequences. To pass the course the student must pass each and every one of the sections of the evaluation. For the Second Opportunity, the results of each section on the First Opportunity will be preserved. If the conditions for passing are not met, the final mark will be the minimum between 4.5 and that result from the sum of the sections. In the case of part-time students, failure to attend SGT classes and practices which are duly justified will not be penalized. An student can get bonus points for doing the activities in English (for example, deliver the report of a lab assignment in English, present an exercise in English, etc). In no case he/she will be penalized for performing activities in Spanish and/or Galician.

According to article 14, section 4, of the evaluation regulations, all students who plagiarize the work of others or provide a copy of their work will be marked with FAIL, and therefore a failing grade for the two opportunities.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Benjamin C. Pierce (2002). Types and Programming Languages. The MIT Press, Cambridge, MA</li> <li>- Kim B. Bruce (2002). Foundations of Object-Oriented Languages: Types and Semantics. The MIT Press, Cambridge, MA</li> <li>- Michael L. Scott (2009). Programming Language Pragmatics. Third edition. Morgan Kaufmann Publishers, Burlington, MA</li> <li>- Fortnow, Lance (2013). P, NP, and the search for the impossible. Princeton University Press</li> </ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>- Franklyn A. Turbak and David K. Gifford (2008). Design Concepts in Programming Languages. MIT Press, Cambridge, MA</li> <li>- Robert W. Sebesta (2010). Concepts of Programming Languages. Pearson</li> <li>- David A. Watt (2004). Programming Language Design Concepts. John Wiley and sons, Chichester, West Sussex, England</li> </ul>                                                                                                                            |

## Recommendations

### Subjects that it is recommended to have taken before

Programming Paradigms/614G01014

Theoretical Computer Science/614G01039

### Subjects that are recommended to be taken simultaneously

Language Processing/614G01067

### Subjects that continue the syllabus

## Other comments

- According to the different regulations applicable to university teaching, the gender perspective will be incorporated in this subject (non-sexist language will be used, the intervention of male and female students in class will be encouraged, etc.).- Work will be done to identify and modify sexist prejudices and attitudes, and the environment will be influenced in order to modify them and promote values of respect and equality.- In case of detecting situations of gender discrimination, actions and measures to correct them will be proposed.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.