



## IDENTIFYING DATA

### Concurrency and distribution

|                   |  |           |      |            |
|-------------------|--|-----------|------|------------|
| Subject           | Concurrency and distribution   |           |      |            |
| Code              | O06G151V01308  |           |      |            |
| Study programme   | Grado en Ingeniería Informática  |           |      |            |
| Descriptors       | ECTS Credits   | Choose    | Year | Quadmester |
|                   | 6  | Mandatory | 3rd  | 2nd        |
| Teaching language | #EnglishFriendly<br>Spanish<br>Galician                                    |           |      |            |
| Department        |  |           |      |            |
| Coordinator       | González Moreno, Juan Carlos<br>A0570-Ax2tc-4 A0570-Ax2tc-4, A0570-Ax2tc-4 |           |      |            |
| Lecturers         | A0570-Ax2tc-4 A0570-Ax2tc-4, A0570-Ax2tc-4<br>López Fernández, Hugo        |           |      |            |
| E-mail            | direc.profesorado@uvigo.es<br>jcmoreno@uvigo.es                            |           |      |            |
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**General description** The content forms the necessary basis to understand the operation of competing and / or distributed applications, the evaluation of competing algorithms, the description of data and information in distributed systems, the operation of modern processors, and the specific characteristics of the programming with processes / threads even in a distributed way.

The classes are given mainly in Spanish. The student can choose to work in Galician, Spanish, German, Portuguese, and / or English. Certain additional information (such as manuals and additional information) will be given in English.

English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

## Training and Learning Results

|      |   |
|------|---|
| Code |   |
| A1   | Students will have shown they have sufficient knowledge and understanding of an area of study, starting after completion of general secondary education, and normally reaching a level of proficiency that, being mostly based on advanced textbooks, will also include familiarity with some cutting-edge developments within the relevant field of study. |
| A2   | Students will be able to apply their knowledge and skills in their professional practice or vocation and they will show they have the required expertise through the construction and discussion of arguments and the resolution of problems within the relevant area of study.   |
| A3   | Students will be able to gather and interpret relevant data (normally within their field of study) that will allow them to have a reflection-based considered opinion on important issues of social, scientific and ethical nature.   |
| A5   | Students will acquire the learning skills that are required to pursue further studies with a high degree of independence.   |
| B5   | Ability to conceive, develop and maintain computing systems, services and applications through use of software engineering methods as tools to ensure quality, according to the knowledge and training acquired.  |
| B6   | Ability to conceive and develop centralized or distributed computing systems and architectures, integrating hardware, software and networks, according to the knowledge and training acquired.  |
| B9   | Ability to solve problems by taking the initiative, making decisions and acting independently and creatively. Ability to communicate the knowledge contents, skills and abilities of the Computer Science Engineer profession.  |
| C14  | Ability to analyze, design, build and maintain applications in a robust, safe and efficient way, choosing the most appropriate paradigm and programming languages.  |
| C15  | Ability to know, understand and assess the structure and architecture of computers, as well as their basic components.  |
| C16  | Knowledge of the characteristics, functions and structure of Operating Systems and design and implementation of applications based on their services.   |

- C17 Knowledge and application of the characteristics, functions and structure of Distributed Systems, Computer Networks and the Internet and design and implementation of applications based on them.
- C20 Knowledge and application of the fundamental principles and basic techniques of parallel, concurrent, distributed and real-time programming.
- C28 Ability to identify and analyze problems and design, develop, implement, verify and document software solutions on the basis of sound knowledge of the theories, models and techniques available nowadays.
- D4 Analysis, synthesis and evaluation capacity
- D5 Organizational and planning skills
- D6 Ability to abstract: ability to create and use models that reflect real situations
- D7 Ability to search, relate and structure information from various sources and to integrate ideas and knowledge.
- D8 Ability to work in situations of lack of information and / or under pressure
- D10 Interpersonal relationship skills.
- D11 Critical thinking
- D14 Have motivation for quality and continuous improvement

### Expected results from this subject

| Expected results from this subject  | Training and Learning Results |    |     |     |
|---|-------------------------------|----|-----|-----|
| RA2: To know systems and environments with concurrency and distribution.                                    | A1                            | B5 | C14 | D4  |
|   | A2                            | B6 | C15 | D5  |
|   | A3                            | B9 | C16 | D6  |
|   | A5                            |    | C17 | D7  |
|   |                               |    | C20 | D8  |
|   |                               |    | C28 | D11 |
|   |                               |    |     | D14 |
| RA3: To know the process of generating applications for concurrent and distributed systems.                 | A1                            | B5 | C14 | D4  |
|   | A2                            | B6 | C15 | D5  |
|   | A3                            | B9 | C16 | D6  |
|   | A5                            |    | C17 | D7  |
|   |                               |    | C20 | D8  |
|   |                               |    | C28 | D10 |
|   |                               |    |     | D11 |
|   |                               |    |     | D14 |
| RA4: To know the tools and their properties in use to generate code for concurrent and distributed systems. | A1                            | B5 | C14 | D4  |
|   | A2                            | B6 | C15 | D6  |
|   | A3                            | B9 | C16 | D7  |
|   | A5                            |    | C17 | D8  |
|   |                               |    | C20 | D10 |
|   |                               |    | C28 | D11 |
|   |                               |    |     | D14 |

### Contents

| Topic   |   |
|---|---|
| Concurrent and distributed systems            | <ul style="list-style-type: none"> <li>- Concept of concurrent and distributed programming</li> <li>- Introduction to the modeling of competing or distributed systems</li> <li>- Hardware architectures for the concurrence and distribution</li> <li>- Tools for the development of competing and distributed applications</li> </ul>   |
| Processes                                     | <ul style="list-style-type: none"> <li>- Concept of processes</li> <li>- Scheduler</li> <li>- Atomicity and mutual exclusion</li> <li>- Transactional concurrence</li> <li>- Clock and distributed status</li> </ul>  |
| Synchronisation and communication             | <ul style="list-style-type: none"> <li>- Synchronization and communication in concurrent and distributed systems</li> <li>- Synchronization and communication at the low level</li> <li>- Synchronization and communication at the high level</li> <li>- Security and vivacity in competing and distributed systems</li> </ul>  |
| Programming and application development tools | <ul style="list-style-type: none"> <li>- Concurrent and distributed programming with JAVA</li> <li>- Concurrent and distributed programming with C / C ++</li> <li>- Design patterns for the development of concurrent and distributed applications</li> <li>- Tools and methodologies of design, verification and debugging of competing and distributed applications</li> </ul> |

### Planning

|   | Class hours | Hours outside the classroom | Total hours |
|---|-------------|-----------------------------|-------------|
| Lecturing   | 17          | 17                          | 34          |
| Previous studies                                      | 0           | 15                          | 15          |
| Laboratory practical                                  | 24          | 24                          | 48          |
| Problem solving                                       | 1           | 20                          | 21          |
| Presentation  | 0           | 4                           | 4           |
| Problem and/or exercise solving                       | 3           | 9                           | 12          |
| Essay questions exam                                  | 0           | 2                           | 2           |
| Report of practices, practicum and external practices | 0           | 12                          | 12          |
| Laboratory practice                                   | 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  |
|----------------------|--|
| Lecturing            | Description of the theoretical contents of the course.<br>Presentation of examples and cases studies.<br>Previous readings.<br>Control of knowledge acquisition by of the student.<br>Interaction with/between the students via specific activities.   |
| Previous studies     | Reading of documents related with the contents of the course.<br>Analysis and design of the tasks of the laboratory work.  |
| Laboratory practical | Implementation and debugging of the exercises posed like programming tasks.<br>Proofs of operation and/or performance of concurrent applications and distributed with a critical analysis of the observations.<br>CONTINUOUS EVALUATION<br>Character: Mandatory<br>Assistance: No mandatory<br>GLOBAL EVALUATION<br>Character: Mandatory |
| Problem solving      | Resolution of problems. Verification, correction and performance analysis.<br>Implementation of alternative solutions.<br>Critical analysis of the proposed solutions .  |
| Presentation         | Brief description of the milestones reached in the programming tasks and related exercises.  |

### Personalized assistance

| Methodologies   | Description  |
|---|--|
| Lecturing   | The professor summarises the information and the knowledge inherent to the course contents, interrelating the different parts and linking the concepts between them, with the bibliography and with the practices. |
| Presentation  | The student exposes to the teacher and/or to a group of students the design of a solution and the obtained results .   |
| Laboratory practical                                  | The student works in the tasks published during the course with the teachers' support.   |
| Tests   | Description  |
| Essay questions exam                                  | The student answers a set of questions with rational arguments.  |
| Report of practices, practicum and external practices | The student elaborates reports documenting the decisions taken and the results obtained including critical reasoning.  |
| Laboratory practice                                   | The student demonstrates his/her implementations of the programming tasks according to the specified requirements.   |
| Problem and/or exercise solving                       | The student provides an informal demonstrates that the solutions have the required properties.   |

### Assessment

|              | Description   | Qualification | Training and Learning Results   |
|--------------|---|---------------|---|
| Presentation | (P5) Development of algorithms or applications and their analysis with a certain level of formalism to check the correctness and study the performance. Assessment with a score of 1-10, optional and voluntary participation. (RA1, RA2, RA3, RA4) | 5             | B5 C14 D4<br>B6 C15 D5<br>B9 C16 D6<br>C17 D7<br>C20 D8<br>C28 D11<br>D14 |

|   |   |    |                                     |  |   |   |
|---|---|----|-------------------------------------|--|---|---|
| Problem and/or exercise solving                       | (P1) Set of short questions for the control of carrying out activities, homework, and studies. Average of the tests carried out have a score of 1-10. (RA1, RA2, RA3, RA4)  | 10 | A1<br>A2<br>B9<br>C17<br>C20<br>C28 | B5<br>B6<br>C16<br>D8<br>D11<br>D14              | C14<br>C15<br>D7<br>D8<br>D11<br>D14              | D4<br>D6<br>D7<br>D8<br>D11<br>D14              |
| Essay questions exam                                  | (P2) Set of long questions that relate the different sections of the content and measure the level of acquisition of the competences of the subject. Test with score of 1-10, minimum required: 4. (RA1, RA2, RA3, RA4)   | 40 | A1<br>A2<br>B9<br>C17<br>C20<br>C28 | B5<br>B6<br>C16<br>D8<br>D11<br>D14              | C14<br>C15<br>D7<br>D8<br>D11<br>D14              | D4<br>D6<br>D7<br>D8<br>D11<br>D14              |
| Report of practices, practicum and external practices | (P3) Preparation of reports (according to a guide) that collect the main developments and results obtained by the student. Some of these reports will be produced in small groups. Average of evaluations of the activities with scores of 1-10. (RA1, RA2, RA3, RA4) | 25 | A3<br>A5<br>B9<br>C17<br>C20<br>C28 | B5<br>B6<br>C16<br>D7<br>D8<br>D10<br>D11<br>D14 | C14<br>C15<br>D6<br>D7<br>D8<br>D10<br>D11<br>D14 | D4<br>D5<br>D6<br>D7<br>D8<br>D10<br>D11<br>D14 |
| Laboratory practice                                   | (P4) Demonstration of the developments and implementation of the programming tasks and study experiments. Average of evaluations of the activities with scores of 1-10., Minimum required: 4. (RA1, RA2, RA3, RA4)  | 25 | A3<br>A5<br>B9<br>C17<br>C20<br>C28 | B5<br>B6<br>C16<br>D7<br>D8<br>D10<br>D11<br>D14 | C14<br>C15<br>D6<br>D7<br>D8<br>D10<br>D11<br>D14 | D4<br>D5<br>D6<br>D7<br>D8<br>D10<br>D11<br>D14 |

### Other comments on the Evaluation

**CONTINUOUS ASSESSMENT SYSTEM TEST 1: Resolution of problems and/or exercises**  
**Description:** Set of short questions to control the performance of activities, tasks, and studies. Average of tests performed with a score of 1-10. This test is mandatory  
**Applied Methodology(s):** Lecture + Previous Study + Problem Solving  
**Rating:** 10%  
**Minimum:** For the release of this part of the subject, the student must obtain a grade equal to or greater than 5 points (out of 10).

**TEST 2: Examination of development questions**  
**Description:** Set of long questions that relate the different sections of the contents and measure the level of acquisition of the subject's competences. Test with a score of 1-10, minimum required: 4. This test is mandatory and will take place on the exam date set for the subject.  
**Applied Methodology(s):** Lecture + Preliminary Study  
**Rating:** 40%  
**Minimum:** For the release of this part of the subject, students must obtain a grade equal to or greater than 5 points (out of 10). To be able to average with the rest of the tests, it is required to achieve at least a score of 4 points.

**TEST 3: Practice Report**  
**Description:** Preparation of reports (following a guide that will be provided) that include the main developments and results obtained. Part of the evaluation is done with "quizzes" live. Average of the evaluations of the activities with scores from 1-10. This test is mandatory.  
**Methodology(s) applied(s):** Laboratory practices.  
**Rating:** 25%  
**Minimum:** For the release of this part of the subject, the student must obtain a grade equal to or greater than 5 points (out of 10) in the final grade of the test.

**TEST 4: Laboratory practice**  
**Description:** Demonstration of the developments and implementations of the programming tasks and study experiments. It is calculated with the average of the evaluations of the activities carried out with scores from 1-10. This test is mandatory.  
**Methodology(s) applied:** Laboratory practices  
**Rating:** 25%  
**Minimum:** For the release of this part of the subject, the student must obtain a grade equal to or greater than 5 points (out of 10) in the final grade of the test. A minimum of 4 points is required to pass the rest of the compulsory tests.

**TEST 5: Presentation**  
**Description:** Development of algorithms or applications and their analysis with a certain level of formalism to verify correctness and study performance. Evaluation with a score of 1-10. This test is voluntary.  
**Methodology(s) applied:** Presentation  
**Rating:** 5%  
**Minimum:** The voluntary nature of this test means that a minimum is not required for its passing. Your score is added to the final grade according to the formula below.

□ The final mark in continuous assessment is obtained as follows, assuming that each test (P1-P5) has been evaluated on a scale of 0-10:  
The subject is failed if tests 2 and 3 reach at least 4 points (in the minutes it will appear as the highest grade of the section that motivates the failure). The subject is approved if it is fulfilled that  $\min(10, 0.1*P1+0.4*P2+0.25*P3+0.25*P4+0.05*P5)$  is greater than or equal to 5, otherwise it is failed.  
□ The spirit of calculating the final grade for the subject in the CONTINUOUS ASSESSMENT system is as follows: there is a combination of theoretical and practical tests throughout the course and at its end to assess the skills acquired. Good results in one part can compensate for not so good results in another part; however, a minimum must be reached in the two most relevant sections (Test 2 and 4).

**GLOBAL EVALUATION SYSTEM**  
**Procedure for choosing the global assessment modality:** Since the default assessment system is CONTINUOUS ASSESSMENT, it is considered that all enrolled students opt for said system. In case of wanting to be

evaluated through the GLOBAL EVALUATION system, "Once the period of one month from the beginning of the semester has passed, a period of 5 working days will be enabled for the students enrolled in the subject to formally state their intention to benefit from the GLOBAL EVALUATION

system[]).=====

=====TEST 1: Practice ReportDescription: Preparation of reports (following a guide that will be provided) that include the main developments and results obtained. Part of the evaluation is done with "quizzes" live. Average of the evaluations of the activities with scores from 1-10. This test is mandatory.Methodology(s) applied(s):

Laboratory practices.Rating: 10%Minimum: For the release of this part of the subject, the student must obtain a grade equal to or greater than 5 points (out of 10) in the final grade of the test.

TEST 2: Laboratory practiceDescription: Demonstration of the developments and implementations of the programming tasks and study experiments. It is calculated with the average of the evaluations of the activities carried out with scores from 1-10. This test is mandatory.Methodology(s) applied: Laboratory practicesRating: 10%Minimum: For the release of this part of the subject, the student must obtain a grade equal to or greater than 5 points (out of 10) in the final grade of the test. A minimum of 4 points is required to pass the rest of the compulsory tests.

TEST 3: Examination of development questionsDescription: Set of long questions that relate the different sections of the contents and measure the level of acquisition of the subject's competences. Test with a score of 1-10, minimum required: 4. This test is mandatory and will take place on the exam date set for the subject.Applied Methodology(s): Lecture + Preliminary StudyRating: 80%Minimum: For the release of this part of the subject, students must obtain a grade equal to or greater than 5 points (out of 10). To be able to average with the rest of the tests, it is required to achieve at least a score of 4 points.

□ The final grade for the subject is calculated using the weighted average of the previous tests. In order to take said average, the student must achieve at least a 4 in tests 2 and

3.=====

=====EVALUATION CRITERIA FOR EXTRAORDINARY CALL AND FINAL DEGREEThe continuous and global evaluation systems described above will be used.RECORD QUALIFICATION PROCESSRegardless of the evaluation system and the call, if all the mandatory tests described above are not passed with more than a four, the mark that will appear in the minutes will be 4.EVALUATION DATEThe dates of the tests corresponding to the continuous assessment system will be published in the calendar of activities, available on the ESEI website

<https://esei.uvigo.es/docencia/horarios/>.The official exam dates of the different calls, officially approved by the Xunta de Centro of the ESEI, are published on the ESEI website <https://esei.uvigo.es/docencia/horarios/>.

USE OF MOBILE DEVICESAll students are reminded of the prohibition of the use of mobile devices in exercises and practices, in compliance with article 13.2.d) of the University Student Statute, regarding the duties of university students, which establishes the duty to "Refrain from using or cooperation in fraudulent procedures in the evaluation tests, in the works that are carried out or in official documents of the university."

CONSULTATION/REQUEST FOR TUTORIALSThe tutorials can be consulted through the personal page of the teaching staff, accessible through <https://esei.uvigo.es/docencia/profesorado/>

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### Sources of information

#### Basic Bibliography

#### Complementary Bibliography

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### Recommendations

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