



## IDENTIFYING DATA

### Physics: Analysis of Linear Circuits

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |      |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------|
| Subject             | Physics: Analysis of Linear Circuits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |      |
| Code                | V05G300V01201                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |      |
| Study programme     | Degree in Telecommunications Technologies Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |      |
| Descriptors         | ECTS Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Choose          | Year |
|                     | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Basic education | 1st  |
| Teaching language   | Spanish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |      |
| Department          | Signal Theory and Communications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |      |
| Coordinator         | García Mateo, Carmen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |      |
| Lecturers           | Cardenal López, Antonio José<br>García Mateo, Carmen<br>García-Tuñón Blanca, Inés<br>Gómez Araújo, Marta<br>Prol Rodríguez, Miguel                                                                                                                                                                                                                                                                                                                                                                                                 |                 |      |
| E-mail              | carmen.garcia@uvigo.es                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |      |
| Web                 | <a href="http://www.faitic.uvigo.es">http://www.faitic.uvigo.es</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |      |
| General description | The course introduces the fundamentals of the lumped circuit principles and abstractions on which the design of electronic systems is based. These include lumped circuit models for sources, resistors, inductors, and capacitors. It intends to present some techniques to analyze (to determine currents and voltages) such systems: conventional analysis (integer-differential analysis, phasors and impedances in sinusoidal regime) and linear systems theory based analysis (by using the Laplace and Fourier transforms). |                 |      |

## Competencies

|      |                                                                                                                                                                                                                                                                                                                                          |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Code |                                                                                                                                                                                                                                                                                                                                          |
| B3   | CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations                                                                                                                                   |
| B4   | CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.                                                                                     |
| C4   | CE4/FB4: Comprehension and command of basic concepts in linear systems and their related functions and transforms; electric circuits theory, electronic circuits, physical principles of semiconductors and logical families, electronic and photonic devices, materials technology and their application to solve Engineering problems. |
| D2   | CT2 Understanding Engineering within a framework of sustainable development.                                                                                                                                                                                                                                                             |
| D3   | CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.                           |

## Learning outcomes

|                                                                                                 |                               |    |    |
|-------------------------------------------------------------------------------------------------|-------------------------------|----|----|
| Expected results from this subject                                                              | Training and Learning Results |    |    |
| To know the elements and laws involved in lumped circuit analysis.                              |                               | C4 |    |
| To show the ability to analyse linear circuits in different circumstances:                      | B4                            | C4 | D2 |
| - to know how to choose among different alternatives when solving a problem.                    |                               |    |    |
| - to know simplifying techniques, their constraints, and how to decide which ones must be used. |                               |    |    |
| To translate the time domain into the transformed domains, by using transforms basic concepts.  |                               | C4 |    |
| To be able to qualitatively justify the role played by circuit elements and their interactions. | B3                            | C4 | D3 |
| To master the language and symbolism of the discipline                                          | B3                            | C4 | D3 |

## Contents

## Topic

|                                      |                                                                                                                                                                                                                                                                                                         |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Presentation and Introduction.       |                                                                                                                                                                                                                                                                                                         |
| I: DC Steady-State Response          | Fundamental and derived magnitudes.<br>Active and passive elements and their functional relationships.<br>Kirchhoff's laws.<br>Analysis by the technique of mesh voltages. Analysis by the techniques of node currents.<br>Simplifying techniques; Thévenin and Norton equivalent circuits.             |
| II: Sinusoidal Steady-state Response | Definition and parameters.<br>Concepts of phasor and impedance.<br>Mesh and node analysis of steady-state sinusoidal regime networks.<br>Divisor circuits.<br>Autoinductance and mutual inductance.<br>Linear and ideal transformers.<br>Power expressions.<br>Thévenin and Norton equivalent circuits. |
| III: Two-Port Circuits               | Definition of a two-port circuit.<br>Characteristic parameters.<br>Combining two-ports.<br>A two-port in a circuit.                                                                                                                                                                                     |
| IV: Transient Response               | Transient regime origin.<br>Conditions of study.<br>Inductors and capacitors in steady-state continuous regime.<br>Single reactive element circuits.                                                                                                                                                    |
| V: Signals and Systems               | Types of signals.<br>Some relevant signals: step function, unit impulse function, exponential function, sinusoidal function.<br>Types of systems.<br>System properties; linear, time invariant systems; impulse response.                                                                               |
| VI: The Laplace Transform            | Definition.<br>Direct transforms.<br>Inverse transform determination.<br>Application to linear circuits.<br>The transfer function.<br>Steady-state response in a circuit.<br>Response to a sinusoidal input.                                                                                            |
| VII: Frequency Selective Filters     | Filter concept.<br>Filter types.<br>Filter responses.                                                                                                                                                                                                                                                   |

## Planning

|                         | Class hours | Hours outside the classroom | Total hours |
|-------------------------|-------------|-----------------------------|-------------|
| Introductory activities | 1           | 0                           | 1           |
| Lecturing               | 24          | 48                          | 72          |
| Problem based learning  | 19.5        | 19.5                        | 39          |
| Laboratory practices    | 3           | 3                           | 6           |
| Problem solving         | 4.5         | 13.5                        | 18          |
| Laboratory practice     | 1           | 3                           | 4           |
| Essay questions exam    | 2           | 8                           | 10          |

\*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

## Methodologies

|                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Introductory activities | Presentation of the course: syllabus, bibliography, teaching methodology, and assessment and grading procedures.<br>Through this methodology the competencies CT2 and CT3 are developed.                                                                                                                                                                                                                                                                |
| Lecturing               | The goal of this methodology is the presentation of the theoretical contents and the practical assessment about students learning abilities.<br><br>Different exercises and problems related to the specific subject will be solved during these sessions, by the Professor or the students with his/her support, either individually or working in a group.<br><br>Through this methodology the competencies CG3, CG4, CE4, CT2 and CT3 are developed. |

Problem based learning These sessions will consist on a supervised either individual or team problem solving of practical applications related to the theoretical content of the subject.

The solutions could be analyzed, checked and compared using computational tools.

At the end of 3 sessions, students will solve a evaluable task in a individual way.

Through this methodology the competencies CG3, CG4 and CE4 are developed.

Laboratory practices Two practical sessions will be carried out in the hardware lab, assembling and measuring circuits tasks will be covered. Out of the total of 4 hours, 1 hour will be dedicated to the evaluation of these sessions.

Through this methodology the competencies CG3, CG4 and CE4 are developed.

### Personalized attention

| Methodologies        | Description                                                                                                                                                                                                                          |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lecturing            | Needs and study matter queries of students will be address by the instructors on office hours.                                                                                                                                       |
| Laboratory practices | Instructors set the pace of the session and resolve any questions that arise during the realization of practice. Also on the office hours, instructors address the needs and queries of the students related to laboratory practice. |

### Assessment

|                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Qualification | Training and Learning Results |          |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------|----------|
| Problem solving      | <p>There will be 3 tests in Group A schedule: ECA1, ECA2 and ECA3. The score of each of these three tests will be: 1.5, 3 and 3 points, respectively. To pass the subject by continuous evaluation, it is compulsory to attend all three tests and obtain at least 0.75 points in the ECA3 test.</p> <p>In 3 of the 11 sessions of Group B the resolution of an evaluable task (ECB1, ECB2, ECB3) with a maximum score of up to 0.5 points each will be considered, which means a total of 1.5 points.</p> <p>The schedule of the tests will be approved in the CAG and will be available at the beginning of the semester.</p> | 90            | B3                            | C4<br>B4 |
| Laboratory practice  | <p>This test (ECHW) is done during Group B hours in the hardware laboratory. The specific day will be approved by the academic board (CAG) and will be available at the beginning of the semester. It is a test related to assembly and measurement of circuits, and will have a maximum score of 1 point. In these exercises the ability to work in groups, the adjustment to the design specifications and the presentation of results will be evaluated.</p> <p>In order to pass the subject by continuous evaluation, attendance at the two lab sessions (hardware) and its corresponding one is mandatory.</p>             | 10            | B3                            | C4<br>B4 |
| Essay questions exam | <p>Additionally to the continuous evaluation system based on the results achieved on the aforementioned tests, the students will have the option of a final examination. This final exam can include test type and/or reasoning questions, problem solving and/or exercises, as well as the development of practical cases. The maximum mark achieved on this exam will be 10 points.</p>                                                                                                                                                                                                                                       | 0             | B3                            | C4<br>B4 |

### Other comments on the Evaluation

The student, in agreement to the official academic-year schedule, will have two opportunities during the academic year to pass the course:

**1. First opportunity at the end of the semester.** The student is free to choose the continuous evaluation system above described, without excluding the possibility to do a final exam. Possible cases:

- The marks in all the evaluation tests are individual.
- Students only doing the continuous evaluation (addition of the ECA1,ECA2,ECA3,ECB1,ECB2,ECB3 and ECHW scores): they are graded with the points obtained in the continuous evaluation.
- Students doing both the continuous evaluation and the exam: they are graded with the best of both qualifications.

- Students only doing the final exam: they are graded with the points obtained in the exam.

**2. Second opportunity (or Extraordinary Exam).** Students that do not reach the minimum grade at the end of the semester will have the option to do a final extraordinary exam of the full content of the subject, theory and practice. The extraordinary exam can include test type and/or reasoning questions, problem solving and/or exercises, as well as the development of practical cases. The maximum mark achieved on this exam (between 0 and 10) will be the final grade. It will replace the grade obtained during continuous evaluation (sum of the grades obtained during tests and final exam).

**Additional comments:**

- Students must attend to the group B assigned at the beginning of the semester.
- Group B attendance control will be carried out.
- Doing ECA2 or successive tests and/or the final exams will prevent the student to get the "Not presented" mark.
- The mark obtained during continuous evaluation will only be valid only for the corresponding academic year.
- It will be considered that the subject has been passed if the final mark is equal or above 5.

**Re-scheduling of tests.** In case of missing a test, instructors have not any compulsion to rescheduling.

**Test results.** Before each test, the date and revision procedure of assigned grading marks will be indicated. Such dates will imply a reasonable delay (in general, not greater than three weeks) between the date of test and the release of the grading marks.

**Sources of information**

**Basic Bibliography**

James W. Nilsson, **Electric Circuits**, 10,  
Material docente, **Página web**, [fatic.uvigo.es](http://fatic.uvigo.es),

**Complementary Bibliography**

J.H. McClellan, R.W. Schafer, M.A. Yoder, **Signal Processing First**,

**Recommendations**

**Subjects that continue the syllabus**

Physics: Fundamentals of Electronics/V05G300V01305  
Digital Signal Processing/V05G300V01304  
Signal Transmission and Reception Techniques/V05G300V01404  
Microwave Circuits/V05G300V01611  
Radio Frequency Circuits/V05G300V01511  
Analogue Electronics/V05G300V01624  
Engineering of Electronic Equipment/V05G300V01523

**Subjects that are recommended to be taken simultaneously**

Mathematics: Calculus 2/V05G300V01203

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

Mathematics: Linear algebra/V05G300V01104  
Mathematics: Calculus 1/V05G300V01105

**Other comments**

It is strongly recommended that students are familiar with complex numbers, trigonometric functions, linear equation system solving, elemental function derivatives and computation of simple integrals.