# 820123 - CSEE - Circuits and Signals

## Degree competences to which the subject contributes

### General objectives:
- To acquire the basic knowledge of electricity and circuit theory applied to the study of electrical circuits and systems.
- To acquire the basic knowledge to understand the principles and techniques of circuit analysis and to be able to apply them, identifying the most appropriate technique to the study of electrical circuits.
- To acquire the basic knowledge to understand and analyze the temporal and frequency behavior of electrical circuits.
- To acquire the basic knowledge and to learn software tools for analysis and circuit design.
- To acquire and to develop skills in experimental techniques for measuring electrical circuits.
- To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.

### Specific:
- CEELE-21. Carry out calculations for the design of low and medium voltage electrical installations.

### Transversal:
- 2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

## Prior skills

- Themselves of previous semesters

## Requirements

- None

## Degree competences to which the subject contributes

### Teaching methodology

- The course is divided in lectures (30%), individual work (30%), work in small groups (cooperative, collaborative or other) (20%), and project-based learning (20%).
- The self-learning process is developed by using the Athena Digital Campus, which includes resources, self-assessment questionnaires, and specifications for a workgroup that has to be developed throughout the semester.

### Learning objectives of the subject

- General objectives:
  - To acquire the basic knowledge of electricity and circuit theory applied to the study of electrical circuits and systems.
  - To acquire the basic knowledge to understand the principles and techniques of circuit analysis and to be able to apply them, identifying the most appropriate technique to the study of electrical circuits.
  - To acquire the basic knowledge to understand and analyze the temporal and frequency behavior of electrical circuits.
  - To acquire the basic knowledge and to learn software tools for analysis and circuit design.
  - To acquire and to develop skills in experimental techniques for measuring electrical circuits.
  - To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.
Transversal competences:
- To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.
- Capacity of analysis and synthesis.
- To acquire computer skills through the use of computer software for analysis and simulation of electrical circuits.
- Capacity for independent learning.
- To gain commitment and organizational skills to work with the group.
- To gain oral and written communication.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
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<tr>
<td></td>
<td></td>
<td>Guided activities:</td>
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<tr>
<td></td>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
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</table>
# Content

<table>
<thead>
<tr>
<th>Item 1. Dynamic circuits. Transient analysis of electrical circuits.</th>
<th>Learning time: 35h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
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<tr>
<td></td>
<td>Self study: 21h</td>
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</tbody>
</table>

## Description:

1.3. Linearity and duality.
1.4. Response of a circuit in the time domain. Steady and transient.

## Related activities:

- Collection of problems
- Laboratory Practice: Transient response in RC and RL circuits
- Laboratory Practice: Transient response in RLC circuits

## Specific objectives:

- To learn the properties of a capacitor and what is the model of an ideal capacitor: voltage-current relationships, energy stored, combination of capacitors.
- To learn the properties of an inductor and what is the ideal model of an inductor. Voltage-current relationships, energy stored, combination of inductor.
- To learn the consequences of linearity the linear in capacitors and inductors.
- To learn the duality between capacitors and inductors.
- What are a permanent and a transient response? What is the reason for a transient response?
- To understand, interpret and learn how to determine the response of RC circuit without sources.
- To know the properties of the exponential function and how to determine the time constant.
- What is the initial condition and how is it calculated? When the voltage of the capacitor may be discontinuous?
- How is the power and energy to the RC components?
- To understand, interpret and learn how to determine the response of RC circuits with sources.
- What is the natural response, forced and complete? Of which depends and how do we calculate it?
- What are the singular functions and how is the response of RC circuits to a unit-step and unit-impulse function.
- To understand, interpret and learn to determine the response of RL circuits with and without sources.
- What is the initial condition and how is it calculated? When the current of the inductor may be discontinuous?
- How the power and energy are in RL components.
- What is the full response of a RL circuit?
- To understand, interpret and know the time response of second order circuits.
- What is the characteristic equation of a second order circuit?
- How is the natural response?
- What is the angular frequency and damping, of which it depends and how it is determined.
- To understand, interpret and learn the overdamped, critically damped and underdamped response.
- How to determine the initial conditions and the complete response of second order circuits.
## Item 2. Magnetically coupled circuits.

**Learning time:** 22h 30m  
- **Theory classes:** 7h  
- **Laboratory classes:** 2h  
- **Self study:** 13h 30m

### Description:
- 2.2. Energy considerations.  
- 2.3. Response in transient state. Response to sinusoidal permanent regime.  
- 2.4. Linear transformer. Reflected impedance.  

### Related activities:
- Collection of problems  
- Laboratory Practice: Magnetically coupled circuits

### Specific objectives:
- What is the magnetic coupling?  
- What is the self-induction and mutual induction?  
- How is the polarity between coupled coils?  
- To understand and apply the dot convention.  
- What is it and how to determine the coefficient of magnetic coupling?  
- What are the energy considerations in circuits with magnetic coupling?  
- What are the circuit with mutual inductions equations in transient response.  
- What are the circuit with mutual inductions equations in sinusoidal steady-state.  
- What is it and how to determine the impedance reflected.  
- To understand how the transformer is ideal  
- What are the relationships between voltages and currents in which the ideal transformer and of which they depend on.  
- To know how to measure the mutual inductances and coupling coefficients in magnetically coupled circuits.
### Item 3. title english

<table>
<thead>
<tr>
<th>Learning time: 15h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study : 9h</td>
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</tbody>
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### Description:

3.1. Introduction.
3.2. Forms of Fourier series: trigonometric and complex. One and two sides spectrum.
3.3. Symmetry properties of functions.
3.4. Complete response to periodic forcing functions.

### Related activities:

- Collection of problems
- Laboratory Practice

Learning time: 35h
   - Theory classes: 12h
   - Laboratory classes: 2h
   - Self study: 21h

Description:
   4.2. Laplace transform.
   4.4. Application of the Laplace transform in circuit analysis.
   4.5. Inverse transform. Heaviside expansion theorem.
   4.6. The initial-value and final-value theorems.
   4.7. Convolution and transfer function H(s).

Related activities:
   · Collection of problems
   · Laboratory Practice: Analysis and simulation of electric circuits by computer

Specific objectives:
   · What is a complex frequency?
   · To know the exponentially damped sinusoidal and its relationship with the complex frequency.
   · What are the Laplace transform and its application to the analysis of circuits?
   · To know the properties of the Laplace transform and to apply them to the analysis of electrical circuits.
   · To know how to determine the transform of the excitation signals.
   · How to transform the simple elements of a circuit in operational domain.
   · What are the operational impedance and admittance and how to determine them.
   · To understand and to apply the Laplace transform in circuit analyses.
   · To know how to determine the complete response in circuits with and without initial conditions.
   · To know how to determine the inverse Laplace transform.
   · To understand and to apply the initial-value and final-value theorems.
   · To know the integral of the impulse response and convolution.
   · To know how to determine the transfer function H(s).
   · To know how to determine the response of a circuit from the transfer function H(s).
<table>
<thead>
<tr>
<th>Item 5. Resonance. Frequency response. Filters.</th>
<th>Learning time: 32h 30m</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
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<tr>
<td></td>
<td>Self study: 19h 30m</td>
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**Description:**

5.1. Resonance: Resonance in the parallel circuit theory. Universal resonance curve.
5.4. Filters. Classification and frequency response.

**Related activities:**

- Collection of problems
- Laboratory Practice: Resonant circuits
- Laboratory Practice: Filters and frequency response

**Specific objectives:**

- What is resonance?
- How is the resonance in the parallel circuit theory?
- What are the quality factor and bandwidth and what is their influence on the frequency response of a circuit.
- To know other resonant circuits.
- To know how to determine the influence of frequency on the magnitude and phase.
- To know how to interpret and represent the Bode diagrams.
- To know how to classify filters and their frequency response.
Item 6. Two-port and multiport networks.

Learning time: 10h
- Theory classes: 3h
- Laboratory classes: 1h
- Self study: 6h

Description:
- 6.3. Multi-pole circuits: Resistors multi-terminals, the transistor, controlled sources, the transformer and the operational amplifier.

Related activities:
- Collection of problems
- Laboratory Practice: Analysis and simulation of electric circuits by computer

Specific objectives:
- What is a one-port network and multi-port networks and, especially, two-port networks.
- How we can model the behavior of two-port networks. What are the different types of parameters.
- To know how to determine different parameters: admittance, impedance, hybrid and direct transmission and reverse two-port networks.
- To know how to determine the equivalent circuits for different parameters.
- To understand and to apply the transformation and equivalence between parameters.
- To know such combinations between two-port networks and the relationships between different parameters in the two-port networks combinations.
- To provide examples of multi-terminal components: resistors multi-terminals, transistor, controlled sources, transformer, operational amplifier, and what are their equivalent circuits.

Qualification system

The evaluation system consists of a continuous assessment by means of several tests, that detail to continuation, in order to approach it to a system of evaluation continued.

- Two written exams (controls)
- Practices will be qualified based on the attendance and the activities performed in the laboratory together with the preparation and delivery of practice reports.

The final mark for the course, it is the obtained with the following tests and weights:
- First written exam: 45%
- Second written exam: 45%
- Practical: 10%.

- The course has a reevaluation test. The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)
Regulations for carrying out activities

There are no specific rules. Every study guide for each activity provides the actual dynamics.

Bibliography

Basic:


Complementary:


Others resources:

Notes from the course

Hyperlink

Apunts de l’assignatura