Degree competences to which the subject contributes

Specific:
1. Knowledge and use of electric machines and circuit theory principles.

Learning objectives of the subject

The overall objective of the subject is providing students with the basic skills which are necessary for the electrical circuit analysis in sinusoidal steady-state.

The specific objectives are:
- knowledge of the models for the active and passive components of the electrical circuits,
- Kirchhoff's laws,
- electrical circuits general solution,
- ability of analysis and solution of electrical circuits in direct current and sinusoidal steady-state, the latter using the phasor domain technique,
- learn the notion of instantaneous, active, reactive and apparent power associated with electrical circuits in sinusoidal steady-state,
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- use the Node Analysis (NA) for electrical circuit analysis,
- (grounded and isolated) wye and delta connections,
- power measurement in three phase systems,
- choose the capacitor to improve the installation power factor,
- analyze the distribution system configurations more common (radial and meshed), and
- model transformers as components of the distribution networks, with preferable use of pu values.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
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<td>Total learning time</td>
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<td>50h</td>
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<td>90h</td>
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<td>0.00%</td>
<td>6.67%</td>
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# Content

## 1. SINGLE-PHASE CIRCUIT ANALYSIS

<table>
<thead>
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<th>Description:</th>
<th>Learning time: 19h 15m</th>
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</thead>
<tbody>
<tr>
<td>(Square brackets contain the location of each topic in the theory book of the bibliography &quot;Circuitos monofásicos y trifásicos&quot; [MT])</td>
<td>Theory classes: 12h 50m</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 6h 25m</td>
</tr>
</tbody>
</table>

### 1.1 Sign conventions

### 1.2 Circuit analysis
Analysis of circuits containing voltage and current sources [MT, p. 20]

### 1.3 Circuits in sinusoidal steady-state

### 1.4 Power in sinusoidal steady-state circuits
Instantaneous power absorbed and delivered by an active or passive two-terminal element [MT, p. 62]. Active, reactive, and apparent power in AC circuits [MT, p. 58]. Additivity of active, reactive and apparent complex powers. Power factor [MT, p. 71]. Wattmeters [MT, p. 145]. Reactive power consumption. Power factor correction [MT, p. 71]

### 1.5 Thévenin and Norton equivalent circuits
Thévenin and Norton theorems [MT, p. 92, 98]. Short circuit power [MT, p. 97]. Thévenin-load problems [MT, p. 100]

## 2. NODE ANALYSIS

<table>
<thead>
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<th>Description:</th>
<th>Learning time: 3h 30m</th>
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<td>Theory classes: 2h 20m</td>
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<td>Practical classes: 1h 10m</td>
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</table>

### 2.1 Introduction and definitions

### 2.2 Node analysis (NA). Thévenin equivalent circuit

### 2.3 Modified node analysis (MNA): incorporation of ideal voltage sources and magnetic couplings
3. THREE-PHASE CIRCUIT ANALYSIS

**Description:**
(Square brackets contain the location of each topic in the theory book of the bibliography "Circuitos monofásicos y trifásicos" [MT])

3.1 Three-phase systems justification

3.2 Definitions
Symmetrical and balanced systems [MT, p. 121]. Positive and negative sequences [MT, p. 121]. Symmetrical and unsymmetrical loads

3.3 Three-phase loads study

3.4 Symmetrical systems with symmetrical loads

3.5 Three-phase power measurement
Apparent complex power evaluation in grounded and isolated systems [MT, p. 139]. Measure, by means of wattmeters, of the active and reactive powers in grounded systems [MT, p. 145]. Measure, by means of wattmeters, of the active and reactive powers in isolated systems [MT, p. 145]

**Learning time:** 12h 15m
Theory classes: 8h 10m
Practical classes: 4h 05m

4. DISTRIBUTION NETWORK ANALYSIS

**Description:**
(Square brackets contain the location of each topic in the theory book of the bibliography "Circuitos monofásicos y trifásicos" [MT])

4.1 Voltage drops, losses and conductor section evaluation

4.2 Distribution networks with P-Q loads

**Learning time:** 5h 15m
Theory classes: 3h 30m
Practical classes: 1h 45m
### 5. TRANSFORMER ANALYSIS

**Description:**
(Square brackets contain the location of each topic in the theory book of the bibliography "Transformadores" [TR])

5.1 Ideal single-phase transformer

5.2 Non-ideal single-phase transformer

5.3 Nameplate of the non-ideal transformer
Laboratory tests for parameters determination [TR, p. 47, 85]

5.4 Three-phase transformer

5.5 Cascade and parallel connected transformers
Reduction of a circuit with cascade and parallel connected transformers [TR, p. 63, 134, 79]. Base changes [TR, p. 65]
The evaluation of the course will take into account the four following activities: lab practices (N_PR), partial exam (N_EP), final exam (N_EF) and questions about the lab practices included in the final exam (N_PR_EF). These lab practice questions will also be considered on the final exam assessment (N_EF) with the same weight as any other exam question.

I.e., if the final exam contains m questions, where n from these questions belong to the lab practices, the assessment (over 10) of the final exam (N_EF) is obtained by adding the assessment of the m questions and multiplying the result by 10/m. Furthermore, the assessment (over 10) of the lab practice questions in the final exam (N_PR_EF) is obtained by adding the assessment of the n questions and multiplying the result by 10/n. In other words, the lab practice questions have more weight than the remaining final exam questions.

The partial exam (N_EP), the final exam (N_EF) and the practical questions in the final exam (N_PR_EF) will be valued with a mark between 0 and 10.

The practices of each student (N_PR) will be valued by their lab professor with a mark between 0 and 10. This valuation will consider the results sheet, the student conduct in the practices (active participation will be positively evaluated; passive participation as well as student conduct which could lead to destruction of any device, even if there is no destruction will be negatively valued) and punctuality.

Those repeating students with lab practices passed in previous semesters have the possibility that lab practices are recognized with the note in such semesters (N_PR), or repeat them again to obtain a new assessment. All students must answer the lab questions in the final and re-evaluation exams (N_PR_EF and N_PR_ER), as these notes are not recognized.

The final assessment of the student will be:

\[ N_{FINAL} = 0.2*N_{EP} + 0.6*N_{EF} + 0.1*N_{PR}_{EF} + 0.1*N_{PR} \]

REEVALUATION OF THE COURSE

The students who failed have a new reevaluation of the course. Only the matriculated students in one or both semesters can access to the reevaluation exam. This exam will be taken at the end of the spring semester regular exams and will have identical structure to the final exam (with notes and N_ER and N_PR_ER). The student's final assessment as a result of this reevaluation will be identical to the regular assessment, i.e.:

\[ N_{FINAL} = 0.2*N_{EP} + 0.6*N_{ER} + 0.1*N_{PR}_{ER} + 0.1*N_{PR} \]

where the partial exam assessment (N_EP) corresponds to that obtained in the last matriculated semester by the student (if the student only has been matriculated in one semester, the assessment of such semester is recognized; if the student has been matriculated in both semesters, the assessment of the spring semester is recognized). If the student doesn’t take the reevaluation exam, the assessment obtained in the ordinary period will be maintained.

It is not necessary to take the final exam in order to preserve the right of taking the re-evaluation exam, it is only necessary to have been taking the partial exam (N_EP) or to have an assessment on lab practices (N_PR) [in both cases, the final assessment (N_FINAL) will have a numeric value; otherwise, it will be NP (Non Presented)].
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**Bibliography**

**Basic:**


