240053 - Electrotechnics

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Arnau Dòria Cerezo

Degree competences to which the subject contributes

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

Teaching methodology

The total teaching load of the subject is 59 hours: 49 hours are taught in slate classrooms (30 theory hours and 19 practical hours) and 10 hours dedicated to lab practices. The weekly distribution is:

- Two weekly work sessions in a class (with a duration between one hour and a half and two hours, until the total load of 49 hours), which outlines the basic theory aspects with the support of teaching material and many practical examples.
- Five practical lab sessions of two hours each session (approximately, one session every two weeks).

An additional dedication of one hour and a half for every hour of class is expected from the student, with a slight increase in the last themes.

Next documentation may be consulted for a full knowledge of the working sessions: the theory books 'Circuitos monofásicos y trifásicos' and 'Transformadores', the collection of proposed and solved problems 'Electrotecnia. Enunciados y problemas resueltos', and solution of the previous years exams 'Electrotecnia. Problemas de examen resueltos'. All this material is available in Reprografía ETSEIB.

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,
- Kirchoff'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,
- 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.

**Study load**

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<tr>
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<th>Total learning time: 150h</th>
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<tbody>
<tr>
<td>Hours large group:</td>
<td>50h</td>
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<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<tr>
<td>Hours small group:</td>
<td>10h</td>
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<td>Guided activities:</td>
<td>0h</td>
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<td>Self study:</td>
<td>90h</td>
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### 1. SINGLE-PHASE CIRCUIT ANALYSIS

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

1. **Sign conventions**

2. **Circuit analysis**
   - Analysis of circuits containing voltage and current sources [MT, p. 20]

3. **Circuits in sinusoidal steady-state**

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]

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]

**Learning time:** 19h 15m
- Theory classes: 12h 50m
- Practical classes: 6h 25m

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### 2. NODE ANALYSIS

**Description:**

1. **Introduction and definitions**

2. **Node analysis (NA). Thévenin equivalent circuit**

3. **Modified node analysis (MNA): incorporation of ideal voltage sources and magnetic couplings**

**Learning time:** 3h 30m
- Theory classes: 2h 20m
- Practical classes: 1h 10m
# 3. THREE-PHASE CIRCUIT ANALYSIS

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<th>Learning time: 12h 15m</th>
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<tr>
<td>Theory classes: 8h 10m</td>
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<td>Practical classes: 4h 05m</td>
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**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]

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# 4. DISTRIBUTION NETWORK ANALYSIS

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<th>Learning time: 5h 15m</th>
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<tr>
<td>Theory classes: 3h 30m</td>
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<tr>
<td>Practical classes: 1h 45m</td>
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**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
### 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]
For ordinary evaluation the final mark will be

\[ N_{\text{FINAL}} = 0.1 \times N_{\text{Pr}} + 0.9 \times (0.35 \times N_{\text{P}} + 0.65 \times N_{\text{F}}) \]

where \( N_{\text{Pr}} \) is the mark of lab sessions, \( N_{\text{P}} \) is the mark of the partial exam and \( N_{\text{F}} \) is the mark of the final exam.

Assistance, participation and delivering the final report is a necessary condition for being evaluated. In other cases, the final mark of the course will be NP (Not Presented).

COURSE REEVALUATION:

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. In this case, the final mark will be

\[ N_{\text{FINAL}} = \min(5, N_{\text{R}}) \]

where \( N_{\text{R}} \) is the mark of the reevaluation exam.

Bibliography

Basic: