820016 - STE - Electrical Systems

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2017

Degree:
- BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Juan Antonio García-Alzórriz Pardo, Rodolfo Oseira Goas
Others: Juan Antonio García-Alzórriz Pardo, Rodolfo Oseira Goas, Arnau Dòria Cerezo, Sergi Fillet castellà, Juan Cruz Vaquer

Opening hours
Timetable: Office of the teacher. See timetable in each case.

Prior skills
Those from previous semesters.

Requirements
None.

Degree competences to which the subject contributes

Specific:
1. Understand and apply the theory of electrical circuits and machines.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
820016 - STE - Electrical Systems

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 basic knowledge of electricity applied to the design of low voltage electrical installations.
- To acquire basic knowledge of electrical machines and converters and be aware of its application in electrical systems.
- To acquire basic knowledge of electricity which enable the interpretation of diagrams, catalogs, technical specifications, low voltage directive and others regulations.
- To acquire the ability to learn autonomously new skills and techniques appropriate to the conception and design of electrical installations.

Transversal competences:
- To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.
- To acquire the ability to learn autonomously new skills and techniques appropriate to the conception and design of electrical installations
- Capacity for independent learning.
- To gain commitment and organizational skills to work with the group.
- To gain oral and written communication.

Study load

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

<table>
<thead>
<tr>
<th>Unit 1. introduction</th>
<th>Learning time: 3h 50m</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 1h</td>
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<tr>
<td></td>
<td>Laboratory classes: 1h 30m</td>
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<tr>
<td></td>
<td>Self study : 1h 20m</td>
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</table>

### Description:
1.2. Fundamental magnitudes: charge, current, voltage, power and energy. Unit systems.
1.4. Continuous and discrete signals.

### Related activities:
- Set of problems.
- Laboratory Practice: Basic laboratory instrumentation.

### Specific objectives:
At the end of the topic the student will be able to identify and learn:
- What is a system and an electrical circuit?
- What are the fundamental magnitudes of systems and electrical circuits?
- What are the elements of an electrical circuit and its properties?
- What is an electric model?
- What are the continuous and discrete signals?
Unit 2. Resistive circuit analysis

Learning time: 27h 40m
- Theory classes: 11h
- Laboratory classes: 2h
- Self study: 14h 40m

Description:
2.4. Passive and active elements of a circuit.
2.7. Linearity. Superposition theorem.
2.8. Equivalent circuits.
2.9. Thévenin's and Norton's theorems.
2.10. Maximum power transfer theorem.

Related activities:
- Set of problems.
- Practice lab: experimental verification of the basic laws governing the operation of the electrical circuits.

Specific objectives:
At the end of the topic, the student will be able to learn and know:
- What is the resistor and how is its characteristic curve: current-voltage relationship?
- How is the power in a resistor.
- To know and to apply Ohm’s and Kirchhoff’s laws in resistive circuits.
- How is the currents and voltages balancing in a circuit.
- What is a voltage divider and current divider?
- What are the passive and active elements of a circuit and their differences?
- To know and to apply Tellegen's theorem and how is the power balancing of in a circuit.
- How to analyze the resistive circuits. Knowing how to use the methods of mesh analysis and nodal analysis.
- What is the linearity and the superposition theorem and how to applied to circuit analysis?
- What are equivalent circuits?
- To know and to apply the Thévenin's and Norton's theorems.
- To know and to apply the maximum power transfer theorem.
**Unit 3. Sinusoidal steady-state. Single-phase systems.**

**Description:**
3. 2. Euler's identities. Transformation of the sine function in the frequency domain (jw). Phasor concept. Transformation properties.
3. 3. Domains of representation: time-domain and phasor representation.
3. 4. Ohm's law and Kirchhoff's laws in the frequency-domain (jw).
3. 7. Steady-state analysis of electrical circuits.
3. 8. Power: instantaneous power, average power, active and reactive power. Apparent power and power factor. Complex power.
3. 9. Reactive power compensation.
3. 10. Maximum power transfer theorem.

**Related activities:**
- Set of problems.
- Practical laboratory: Test circuits in sinusoidal permanent regime. Study of tensions, currents and powers AC. Power factor correction.

**Specific objectives:**
At the end of the topic the student will be able to know:
- What is a periodic signal and what are their characteristic values?
- How is the transformation of a sinusoidal exciter function in the frequency-domain (jw)? What Phasor and as applied to the transformation properties of the analysis of circuits in sinusoidal steady-state?
- What are the domains of the signal representation: temporal and phasor representation?
- What are the phasor relationships of passive elements R, L and C. and how they behave in sinusoidal steady-state?
- How are the phasor diagrams?
- To know and to apply the Ohm's law and Kirchhoff's laws for sinusoidal steady state.
- What is the impedance and admittance and how to apply network reduction for sinusoidal steady-state?
- How to analyze circuits for sinusoidal steady state? Knowing how to use the mesh analysis and nodal analysis.
- What are the concepts of sinusoidal steady-state power?
- What is the power factor?
- How it applies the power factor correction?
- How is the theorem of the maximum power transfer in sinusoidal steady-state?
- To know and to apply the maximum power transfer theorem for sinusoidal steady-state.
## Unit 4. Three-phase systems

<table>
<thead>
<tr>
<th>Learning time: 27h 40m</th>
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<tbody>
<tr>
<td>Theory classes: 11h</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study: 14h 40m</td>
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### Description:
1. Polyphase systems and three-phase systems.
2. Three-phase generator. Phase and line voltages. Relationship between phase and line voltages.
5. Single phase loads connected to a three phase power.
7. Reactive power compensation in three phase balanced systems.
8. Three-phase voltages, currents, and power measurement.

### Related activities:
- Collection of problems.
- Laboratory Practice: Three-phase systems. Study of tensions, currents and powers at three-phase systems.

### Specific objectives:
At the end of the topic the student will be able to know:
- What is a polyphase system?
- How a voltage phase is generated?
- What is the relationship between phase and line voltages?
- How are composed of three phase loads?
- How is transforms three-phase loads on star and delta?
- How to analyze networks with three-phase load balanced and unbalanced?
- How to connect Single phase load in three-phase networks?
- What are the concepts of three-phase power system?
- How it performs the power factor correction in three-phase balanced systems?
- What are the methods for measurements voltages, currents and power at three phase systems?
## Unit 5. Single-phase and Three-phase transformers

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 25h 40m</th>
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<tbody>
<tr>
<td>5.1. The general principle of electromagnetic transformation.</td>
<td>Theory classes: 11h</td>
</tr>
<tr>
<td>5.2. Constitution and fundamental values.</td>
<td>Self study: 14h 40m</td>
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<tr>
<td>5.3. Ideal single-phase transformer.</td>
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<td>5.4. Real single-phase transformer.</td>
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<td>5.5. Equivalent electrical circuit.</td>
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<td>5.6. Ratings assigns.</td>
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<td>5.7. Basic test on transformers.</td>
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<td>5.8. Voltage drop.</td>
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<td>5.9. Losses and performance.</td>
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<tr>
<td>5.10. Three-phase transformers. Three-phase banks of single-phase transformers.</td>
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<tr>
<td>5.11. Transformers three columns. Connection groups.</td>
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<tr>
<td>5.12. Special transformers: autotransformers and instrument and protection transformers.</td>
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</tbody>
</table>

### Related activities:
- Problems collection
- Laboratory Practice: Transformers Tests.

### Specific objectives:
- At the end of the topic the student will be able to know:
  - What is the general principle of electromagnetic transformation.
  - Understand the basic principle of operation of a transformer, its constitution and fundamental values.
  - What differences exist between ideal and real single-phase transformer.
  - How is the electrical equivalent circuit of the transformer and its physical meaning.
  - What are the ratings or assigned and how to interpret.
  - What is and what should the voltage drop in a transformer.
  - What are the losses of the transformer, and how determined performance.
  - What is a three-phase transformer.
  - Understand the operation of three phase transformers and the most important features.
  - How banks are made by connecting three-phase single-phase transformers.
  - How are constituted the three columns transformers.
  - How to connect the coils of three-phase transformer windings.
  - The index schedule.
  - Understand the working principle of special transformers: auto-transformers and instrument and protection transformers.
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: 40%
  - Second written exam: 50%
  - Practical and efficient oral and written communication competence: 10%
- The course has a re-evaluation test
**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:**

Hyperlink

*Apunts de l'assignatura*