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# 320128 - IEAT - High Voltage Electrical Installations

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan

## Teaching staff

Coordinator: Ricard Horta Bernús

## Prior skills

Students will be expected to have passed Electrical Power Transmission as well as Electric Machines I and II.

## Degree competences to which the subject contributes

Specific:

1. ELE: Ability to calculate and design high-voltage electrical installations.
2. ELE: Understanding of machine control, electric drive systems and their applications.

## Teaching methodology

- Face-to-face lecture sessions.
- Face-to-face class work sessions.
- Face-to-face laboratory work sessions
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

Practical class work will be covered in three types of sessions:
a) Sessions in which the lecturer will provide students with guidelines to analyse data for solving problems by applying methods, concepts and theoretical results
b) Sessions in which students give presentations of group work
c) Laboratory sessions in which students assemble and test installations and collect data.
d) Examination sessions.

On the Digital Campus, students will have access to all subject-related documentation: theory lectures featuring digital media, answers to exercises, laboratory scripts, and descriptions of the directed assignments.

Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.

In groups of five, students will carry out projects and present them publicly in applied sessions.

## Learning objectives of the subject

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In this subject, students are introduced to the principles for calculating the necessary electrical parameters to design an electrical installation in terms of both the assigned values and the values reached under a short circuit or overload. Students learn to use the right tools to properly design the components of an electrical installation and to choose from among various different methods depending on whether the installation is low-voltage or high-voltage. They will learn to design a protection system (including the selection and adjustment of its constituent elements), become familiar with the operating principles of the various devices employed, and use commercial catalogues.

## Study load

| | | | |
|---|---|---|---|
| Total learning time: 150h | Hours large group: | 30h | 20.00% |
| | Hours medium group: | 15h | 10.00% |
| | Hours small group: | 15h | 10.00% |
| | Guided activities: | 6h | 4.00% |
| | Self study: | 84h | 56.00% |

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## Content

### TOPIC 1: SHORT-CIRCUIT CURRENTS

Learning time: 36h

Theory classes: 11h 15m
Laboratory classes: 3h 45m
Self study : 21h

Description:
- Introduction.
- Symmetrical components.
- Impedances of the elements of an installation.
- Study of various types of short circuit.
- Temporal analysis of short-circuit currents.
- Short-circuit current limiting.

Related activities:
Assembly of a direct-current motor system and synchronous generator. Use of this machine to perform various types of short circuits with appropriate voltages so as not to exceed the assigned values. Measurement and interpretation of the results.
- Assembly of a direct-current motor system and synchronous generator. Use of this machine to perform a series of near-to-generator three-phase short-circuits. Acquisition of voltage and current waveforms in all three phases. Interpretation of the results and identification of the necessary constants to characterise the short-circuit currents.

Specific objectives:
- Understand the importance of calculating short-circuit currents.
- Be able to demonstrate manually the calculations that a piece of software performs.
- Calculate the impedances of the various elements that make up a particular electrical system.
- Understand current calculation expressions and apply them to the appropriate types of short circuits.
- Understand the temporal expressions of short-circuit currents and identify the constants that define them under current regulations.

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| TOPIC 2: HIGH-VOLTAGE SWITCHGEAR | Learning time: 36h<br>Theory classes: 11h 15m<br>Laboratory classes: 3h 45m<br>Self study : 21h |
|---|---|

Description:
- The phenomenon of electrical breakdown.
- Control and protection devices.
- Testing control and protection devices.

Laboratory sessions
- Disassembly of high-voltage switchgear: fuses, breaker poles, disconnectors, circuit breakers.

Related activities:
Description laboratory:
- Display of switchgear scrapyards AT: fuses, powder switches, disconnectors, switches automatic

Specific objectives:
- Acquire a theoretical foundation by studying the electric arc phenomenon and the breaking of resistive, inductive and capacitive electrical circuits.
- Acquire the necessary knowledge to select a switching device according to specific needs and the technologies available on the market.
- Become familiar with the main manufacturers and products that they offer.
- Understand and correctly use the information provided by commercial catalogues.

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## TOPIC 3: GROUNDING INSTALLATIONS

Learning time: 36h

Theory classes: 11h 15m
Laboratory classes: 3h 45m
Self study : 21h

Description:
- General aspects.
- Studying the terrain.
- Preliminary calculations.
- Electrodes and settings.
- Design and dimensioning.
- Grounding installations for substations and transforming stations.
- Measurements and testing.

Laboratory sessions
- Measurement of ground resistivity.
- Measurement of the resistance of a grounding installation.
- Measurement of step and touch voltages, as well as transferred voltages. Potential gradients.

Related activities:
Description laboratory:
- Measurement of ground resistivity
- Measure the resistance of a grounding installation
- Measure voltages step and touch voltages transferred. Potential gradients

Specific objectives:
- Become familiar with methods for measuring resistivity, resistance and voltage in a grounding system. Be able to check installations.
- Understand the technological solutions for grounding installations.
- Know how to apply regulations.
- Become familiar with the terminology used in the field.
- Be able to design a grounding installation to meet a particular set of needs.

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| TOPIC 4: PROTECTION SYSTEMS | Learning time: 36h<br>Theory classes: 11h 15m<br>Laboratory classes: 3h 45m<br>Self study : 21h |
|---|---|

Description:
- Protection of the elements of an electrical installation.
- Coordination between protection systems.

Specific objectives:
- The ability to apply the knowledge acquired in the previous topic.
- An understanding of the protection systems used to protect the elements of an electrical installation.
- An understanding of the methods to coordinate the various systems involved in protecting a single electrical system.
- An understanding of the important role played by protection systems in electrical installations.
- A comprehensive understanding of the subject, including the knowledge acquired over the course of the year, and the ability to relate it to knowledge acquired in other subjects.

## Qualification system

- Exam 1: 20%
- Exam 2: 20%
- Exam 3: 20%
- Exam 4: 20%
- Exam laboratory: 20%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

## Regulations for carrying out activities

Not attend laboratory classes represents an NP assessment items related to the content taught in these sessions

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## Bibliography

### Basic:


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Montané Sangrá, P. Protecciones en las instalaciones eléctricas: evolución y perspectivas. Barcelona: Marcombo Boixareu, 1988. ISBN 8426706886.

Navarro Márquez, J. A. [et al.]. Instalaciones eléctricas de alta tensión: sistemas de maniobra, medida y protección. Madrid: Paraninfo, 1999. ISBN 8428324344.

Horta Bernús, R. Teoria, càlcul i disseny de línies elèctriques [on line]. Barcelona: Edicions UPC, 2001 [Consultation: 11/01/2016]. Available on: <http://hdl.handle.net/2099.3/36217>. ISBN 8483014629.

Espanya. Ministerio de Industria, Comercio y Turismo. Reglamento técnico de líneas eléctricas aéreas de alta tensión: [Decreto 3151/68 de 28 de noviembre]. Madrid: Ministerio de Industria, Comercio y Turismo, 1991. ISBN 8474746248.

Siegert C. Alta tensión y sistemas de transmisión. México: Limusa, 1988. ISBN 9681827945.


### Complementary:


Ras Oliva, E. Transformadores de potencia, de medida y de protección. Barcelona: Marcombo, 1991. ISBN 8426706908.

Ras Oliva, E. Teoría de líneas eléctricas: de potencia, de comunicación, para transmisión en continua, vol. 1 y 2. Barcelona: Marcombo, 1986. ISBN 8460058921.

Cortés Cherta, M. Curso moderno de máquinas eléctricas rotativas, vol. 4. Barcelona: Editores Técnicos Asociados, 1970-1989. ISBN 8471460899.

Checa, Luis María. Líneas de transporte de energía. Barcelona: Marcombo, 1979. ISBN 8426703763.

Cortés Cherta, M. Curso de aparamenta eléctrica. Barcelona: Merlin Gerin, 1990.

García Márquez, R. La puesta a tierra de instalaciones eléctricas y el R.A.T. Barcelona: Marcombo Boixareu, 1991. ISBN 8426707998.


### Others resources:

COMITÉ DE DISTRIBUCIÓN (UNESA), GRUPO DE TRABAJO DE REGLAMENTOS. Guía Tecnica Sobre Cálculo, Diseño y Medida de Instalaciones de Puesta a Tierra en Redes de Distribución HEC. Documentación Técnica Para el Proyecto y Comprovación de Instalaciones de Puesta a Tierra. HEC, 1984