Course guide
320128 - IEAT - High Voltage Electrical Installations

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Ricard Horta Bernús

Others:

PRIOR SKILLS

It is highly recommended to have passed the subject of Electrical Machines I

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. ELE: Ability to calculate and design high-voltage electrical installations.

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

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

Type	Hours	Percentage
Hours medium group	15,0	10.00
Hours small group	15,0	10.00
Hours large group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

TOPIC 1: SHORT-CIRCUIT CURRENTS

Description:
- Introduction
- Symmetrical components
- Impedances of the elements of an installation
- Study of the different types of short circuit
- Temporal analysis of short circuit current
- Limitation of short-circuit currents

Laboratory description:
- Assembly of a direct current motor system and synchronous generator to perform on it the different types of short circuits with adequate voltages so as not to exceed the assigned values â□□â□□of the machine. Measurement and interpretation of results
- Assembly of a direct current motor system and synchronous generator to perform on it a series of three-phase short circuits close to the generator. Capture of current and voltage oscillograms in all three phases. Interpretation of results and obtaining the constants needed to characterize 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.

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.

Full-or-part-time: 51h
Theory classes: 10h
Practical classes: 5h
Laboratory classes: 6h
Self study : 30h

TOPIC 2: HIGH-VOLTAGE SWITCHGEAR

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.

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.

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

Full-or-part-time: 35h
Theory classes: 5h
Practical classes: 5h
Laboratory classes: 4h
Self study : 21h

TOPIC 3: GROUNDING INSTALLATIONS

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.

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.

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

Full-or-part-time: 49h
Theory classes: 10h
Practical classes: 5h
Laboratory classes: 5h
Self study : 29h

TOPIC 4: PROTECTION SYSTEMS

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.

Full-or-part-time: 15h
Theory classes: 5h
Self study : 10h

GRADING 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.

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:
- Roeper, Richard. Corrientes de cortocircuito en redes trifásicas. Barcelona: Marcombo, 1985. ISBN 8426705928.
- A.B.B.. Aparamenta eléctrica de A.T. A.B.B., 2005.
- Vega Ortega, Miguel de la. Problemas de ingeniería de puesta a tierra. 2a ed. México: Limusa, 2001. ISBN 9681857763.
- 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, Ricard. Teoria, càlcul i disseny de línies elèctriques [on line]. Barcelona: Edicions UPC, 2001 [Consultation: 06/05/2020]. 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:
- 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.
- 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.

RESOURCES

Other 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