320026 - IEBT - Low Tension Industrial Installations

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Juan Martínez Magaña

Prior skills
Students who take this subject are expected to have a basic understanding of the following topics: short-circuit current calculation in electrical networks, neutral conductors in electrical installations, electric arc control and interruption devices, calculation of electrical power line parameters, behaviour and parameters of electric machines.

Degree competences to which the subject contributes

Specific:
1. ELE: Applied knowledge of power electronics.

Transversal:
2. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

Teaching methodology
The various activities of the subject will be organised as follows:
- Theory sessions. In-class activities focused on the presentation and discussion of theoretical content. These sessions may be led by the lecturer, the students or both.
- Problem sessions. Activities focused on problem-solving. These sessions will rely heavily on individual or group work.
- Laboratory sessions. Activities focused on laboratory practicals or projects. In these sessions, students will usually work in groups.
- Seminar sessions. Activities focused on the development of dynamics, presentations, or the cooperative completion of exercises. These sessions will rely heavily on individual or group work.
- Assessment sessions. Activities that will be evaluated.
- Individual work. Individual activities outside of the classroom that build students' independent learning skills (studying notes and reading recommended texts, books, articles, etc.), or tasks that foster personal development (projects, exercises, comments, etc.), which students will be required to present.
- Cooperative work. Assessed group activities done outside of the classroom. These activities require the collaboration of several students (discussion of materials, completion of exercises, development of dynamics, preparation of projects, etc.).
At the beginning of the year, students will be given a calendar of all activities planned for the subject.

Learning objectives of the subject
In this subject, students will acquire fundamental knowledge of the design of low-voltage installations and learn about the basic instruments used for this purpose. Specifically, students will acquire a good command of the criteria for selecting electrical conductors in radial or ring circuits. They will learn to take into consideration the restrictions imposed by voltage drops, environmental installation conditions, thermal stress under fault conditions, and the various service regimes corresponding to different consumption levels, as well as economic criteria, with a view to optimising the investment in economic terms. They will also learn to select control and protection devices on the basis of service requirements and to assess the risks associated with the selection of ground connection schemes in low-voltage installations.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 15h</th>
<th>10.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>30h</td>
<td>20.00%</td>
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<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
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<tr>
<td>Guided activities:</td>
<td>6h</td>
<td>4.00%</td>
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<tr>
<td>Self study:</td>
<td>84h</td>
<td>56.00%</td>
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</tbody>
</table>
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## Content

<table>
<thead>
<tr>
<th><strong>TOPIC 1: IN-SERVICE POWER CABLES</strong></th>
<th><strong>Learning time:</strong> 20h</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 7h</td>
</tr>
<tr>
<td>- Introduction to cables and</td>
<td>Practical classes: 4h</td>
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<tr>
<td>distribution systems.</td>
<td>Laboratory classes: 4h</td>
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<tr>
<td>- Voltage drops and sections.</td>
<td>Self study: 5h</td>
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<tr>
<td>- Short-circuit stresses.</td>
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<td>- Cables in intermittent service.</td>
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<tr>
<td>- Thermal circuit.</td>
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<tr>
<td>- Cable thermal resistance.</td>
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<tr>
<td>- Ground thermal resistance.</td>
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<tr>
<td>- Correction coefficients in</td>
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<td>overhead conductors.</td>
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<td>- Correction coefficients in</td>
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<td>underground conductors.</td>
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<tr>
<td>- Ventilation of electrical</td>
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<tr>
<td>conduits.</td>
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<tr>
<td>- Most economical section.</td>
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<tr>
<td><strong>Laboratory sessions</strong></td>
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<tr>
<td>- Design of an installation.</td>
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<tr>
<td>- Selection of sections.</td>
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<tr>
<td>- Calculation of voltage drops.</td>
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<tr>
<td>- Calculation of short-circuit</td>
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<tr>
<td>currents.</td>
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</tbody>
</table>

**Specific objectives:**

- The ability to interpret and use the information provided in manufacturers' catalogues.
- The ability to calculate maximum expected voltage drops in radial and ring systems, and to select conductor sections accordingly.
- The ability to verify that lines are able to withstand the thermal stress generated by their location within a distribution system.
- The ability to redefine a line's load capacity on the basis of the service type of the loads it carries.
- The ability to calculate the correction coefficient of an overhead or underground conductor's load capacity for a given set of installation conditions.
- The ability to carry out a thermal analysis for underground cables or electrical conduits.
- The ability to carry out economic feasibility studies and select the most cost-effective sections.
- The ability to assess the energy consumption and emissions associated with energy distribution.
### TOPIC 2: OVERLOAD AND SHORT-CIRCUIT PROTECTION IN LOW-VOLTAGE INSTALLATIONS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 24h 30m</th>
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<tbody>
<tr>
<td>- Low-voltage electricity distribution networks. Structure and functions.</td>
<td>Theory classes: 9h</td>
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<tr>
<td>- Characteristics of interruption and protection devices.</td>
<td>Practical classes: 5h</td>
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<tr>
<td>- Fuses.</td>
<td>Laboratory classes: 6h</td>
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<tr>
<td>- Current limiting.</td>
<td>Self study: 4h 30m</td>
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<td>- Back-up.</td>
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<td>- Amperometric, time-graded and logical selectivity.</td>
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<td>- Safety distances.</td>
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</tbody>
</table>

#### Laboratory sessions
- Selection of control devices.
- Selection of protection devices.
- Critical paths.
- Device adjustment.
- Trip curves and selectivity.

### Specific objectives:
- The ability to select control devices on the basis of the installation conditions and the required service level.
- The ability to select protection devices on the basis of the required performance level.
- The ability to coordinate the action of back-up protection devices.
- The ability to coordinate the action of selective protection devices.
- The ability to evaluate the general operation of an installation and identify critical points.
TOPIC 3: PROTECTION AGAINST INSULATION DEFECTS IN LOW-VOLTAGE INSTALLATIONS

Learning time: 15h 30m
- Theory classes: 5h
- Practical classes: 4h
- Laboratory classes: 2h
- Self study: 4h 30m

Description:
- Risks of insulation defects
- Grounding systems and personal protection.
- Connection to neutral: TN system.
- Grounded neutral: TT system.
- Insulated neutral: IT system
- Influence of medium voltage on low voltage.
- Selection of a grounding system.
- Functions of differential protection.
- Uses and applications of differentials.
- Coordination of differential devices.

Laboratory sessions
- Placement of differential devices.
- Coordination of devices.
- Action of devices.

Specific objectives:
- The ability to understand an installation's behaviour in the event of insulation failure on the basis of different grounding systems.
- The ability to evaluate the risks associated with the selection of different grounding systems in low-voltage installations.
* Familiarity with the protection requirements associated with each grounding system.
- Familiarity with different protection devices, their operation and their limitations.
- The ability to establish the appropriate safety measures in any situation.
- The ability to select protection devices on the basis of the installation conditions and the required service level.
Qualification system

For each topic of the subject, students will have to take three tests (an individual test on theory, an individual problem-solving test, and a group problem-solving test) and do assessed practicals. Directed assignments may also be assessed.

Marks are weighted as follows:
- Topic 1 test 25 %
- Topic 2 test 25 %
- Topic 3 test 25 %
- Assessed practicals 25 %

Assessment is continuous, consisting of nine assessment activities plus the practicals. At the beginning of the course, students will be given a calendar of all assessment activities and their weights. Students will not be allowed to re-sit any assessment activities they fail or do not complete.

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.
Bibliography

Basic:


Complementary:


Others resources:

Martínez, J. Apuntes de instalaciones de baja tensión 2006.

Norma UNE 20.460. Instalaciones eléctricas en edificios.

HEC. Documentación técnica para el proyecto y comprobación de instalaciones de puesta a tierra. HEC, 1984