Teaching Guide				
Identifying Data				2023/24
Subject (*)	High-voltage electrical installations		Code	770G02027
Study programme	Grao en Enxeñaría Eléctrica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Third	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Industrial			
Coordinador	Méndez Sanmartín, Cristian	E-mail	cristian.mendez@udc.es	
Lecturers	Méndez Sanmartín, Cristian	E-mail	cristian.mendez@udc.es	
Web				
General description	Instalacións Eléctricas de Media e Alta Tensión: Elementos constituyentes. Subestaciones e Aparamenta. Cálculo de Cortocircuitos simétricos e asimétricos. Tratamento do Neutro. Tensión de Restablecimiento. Sobretensiones e Coordinación de Illamento. Protección eléctricas. Instalacións de posta a terra.			

Study programme competences	
Code	Study programme competences
A1	Capacidade para a redacción, firma, desenvolvemento e dirección de proxectos no ámbito da enxeñaría industrial, e en concreto da especialidade de electricidade.
A4	Capacidade de xestión da información, manexo e aplicación das especificacións técnicas e da lexislación necesarias no exercicio da profesión.
A5	Capacidade para analizar e valorar o impacto social e medioambiental das solucións técnicas actuando con ética, responsabilidade profesional e compromiso social, e buscando sempre a calidade e mellora continua.
A26	Capacidade para o cálculo e deseño de instalacións eléctricas de baixa e media tensión.
A27	Capacidade para o cálculo e deseño de instalacións eléctricas de alta tensión.
B1	Capacidade de resolver problemas con iniciativa, toma de decisións, creatividade e razoamento crítico.
B2	Capacidade de comunicar e transmitir coñecementos, habilidades e destrezas no campo da enxeñaría industrial.
B3	Capacidade de traballar nun contorno multilingüe e multidisciplinar.
B4	Capacidade de traballar e aprender de forma autónoma e con iniciativa.
B5	Capacidade para empregar as técnicas, habilidades e ferramentas da enxeñaría necesarias para a práctica desta.
B9	CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio.
C3	Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.

Learning outcomes	
Learning outcomes	Study programme competences

Identifies, classifies and describes electrical installations in BT, MT and AT.	A1	B1	C3
Calculates and designs electrical installations in MT and AT.	A4	B2	
Know and select the characteristics of materials, cables, switchgear and measurement equipment used in MV and AT electrical installations.	A5 A26	B3 B4	
Understands, selects and properly uses electrical protection techniques.	A27	B5	
Select and use appropriate tools for the design of electrical installations in MV and AT.		B9	
Know and use the specific legislation and regulations of MT and AT electrical installations.			
Select and understand the use of technical literature and other sources of information in Spanish and English.			

Contents	
Topic	**Sub-topic**
Summary according to the degree report	Medium and high voltage installations. Switchgear Electrical substations and transformation centers. General characteristics. Protections. Elements and basic strategies for the protection of electrical systems. Protection of fundamental elements of electric power systems. Surges and protection. Introduction to insulation coordination. Quality of service and electricity supply.
Node Admittance and Impedance Matrices	Matrix equations for node analysis by direct inspection of circuits. Matrix equations for node analysis from the connection matrices. Definition of the node admittance matrix. Definition of the node impedance matrix. Incorporation of magnetic couplings. Construction of the node impedance matrix step by step.
Symmetrical Short Circuit Calculation	Balanced three-phase short circuit of a no-load line. Balanced three-phase short circuit of a no-load synchronous machine. Definition of transitory and sub-transitory regimes. Calculation of symmetrical short circuits by the substitution method. Application of the node impedance matrix to the calculation of symmetrical short circuits.
Symmetrical Components	Fortescue?Stokvys theorem. Direct and inverse transformation matrices. Properties of symmetric component systems. Representation of balanced charges. Representation of a balanced system with unbalanced charge. Sequence impedances of synchronous generators, transmission lines and transformers with different connection groups
Calculation of Asymmetric Short Circuits	Rules for the construction of direct, inverse and homopolar sequence circuits. Calculation models with symmetrical components for phase-earth, phase-phase, phase-phase-earth faults. Open conductor faults.
Load Flows	Calculation study of node voltages and load flows. Iterative resolution methods: Newton-Raphson, Gauss-Seidel.
Substations	Elements of the substations. Bar games. Operations with the bars in the substations.

Electric Arc	Physical foundations. Static arc characteristic in direct current. Interruption of the arc in direct current. Interruption of the arc in alternating current.
Circuit Interruption	Disconnectors. Power switches. Types and operation.
Protection of Power Systems	Characteristics and functions of a protection system. Voltage and current transformers. relays. Characteristics. Overcurrent relays. Timed overcurrent relays. Relays with two inputs. General formula for activating a relay. Sequence filters. Bar protection. Transformer protection. Protection of generators and motors. Line protection. Overcurrent protection in radial lines Directional relays. Distance relays (impedance). Modified impedance relays. Relay response to unbalanced faults.
Grounding installations	Definitions. Electrodes and ground lines. Step and touch voltages. Distributions of potential and grounding resistance of basic electrodes. Calculations with multi-electrode systems.
Neutral Treatment in Power Systems	Definitions. Study of the single-phase fault in a network with isolated neutral. Study of the single-phase fault in a network with extinguishing coil. Study of the single-phase fault in a network with the neutral grounded. Definition of the grounding coefficient.
Transient Recovery Voltage (TRV)	Study of the TRV by the current injection method. Calculation of the TRV for a short circuit in the generator terminals. Calculation of the TRV for a kilometer fault. Calculation of the TRV for a fault on the line. First pole factor.
Overvoltage and Insulation Coordination	Types and origin of surges. Traveling waves and surge propagation. Bewley's method for calculating overvoltages. Generation of surges in transmission lines. Direct and indirect downloads. Behavior of lines against lightning. Protection of lines against lightning. Lightning rod. Types and behavior of lightning rods. Isolation Coordination. Basic level of impulse isolation. Standardized test waves for the study of overvoltages. Voltage-time characteristic.

Planning

Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A27 A26 B3 C3	21	0	21
Problem solving	A27 A26 B1 B4 B5 B9 C3	16.5	0	16.5
Laboratory practice	A26 A27 B1 B3 B4 B5 B9 C3	9	0	9
Objective test	B1 B5	4	0	4
Student portfolio	A1 A4 A5 A26 A27 B1 B2 B3 B4 B5 B9 C3	0	90	90
Events academic / information	A1 A4 A5 A26 A27 B1 B2 B3 B4 B5 B9 C3	4.5	0	4.5
Personalized attention		5	0	5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Introductory session to the subject for the introduction of the subject. Explanation of content by the teacher.
Problem solving	Students solve calculation problems proposed by the teacher.
Laboratory practice	Depending on availability / Not confirmed: ---------- Practices where the students are in charge of carrying out assemblies in the workshop where, according to the practice scripts of the subject, the indicated tests are carried out. If it is not possible to allocate this bag of hours to practices, they will be reused in the master session and problem solving.
Objective test	Answer to questions or solve exercises without means of consultation or with restricted means of consultation, in a specific limited space of time.
Student portfolio	Autonomous work: Study and development of skills related to the subject through the development of material or proposals discussed in the master session. Seminars: Presentation of specific topics related to the subject and discussion about them. Activities that can be carried out during the school period: In the case of a proposal by the teacher, a series of recoverable intermediate tests and supervised work could be carried out following the teacher's instructions.
Events academic / information	Depending on availability / Not confirmed: ---------- Events of a scientific and/or informative nature. Lectures or invited classes given by experts or by collaborating companies related to the competencies of each subject. Visits to industrial facilities related to the competences of each subject. If it is not possible to allocate this bag of hours to practices, they will be reused in the master session and problem solving.

Personalized attention	
Methodologies	Description
Student portfolio	The teacher responds individually or in a group to questions or queries made by students.

Assessment			
Methodologies	Competencies	Description	Qualification
Problem solving	A27 A26 B1 B4 B5 B9 C3	20% of the evaluation of this section will be included in the case of carrying out an intermediate test if that were the case. If this were not the case, this percentage would be added to the objective test.	20
Student portfolio	A1 A4 A5 A26 A27 B1 B2 B3 B4 B5 B9 C3	A 20% valuation of this section will be included in the case of carrying out some supervised work if the case arises. If this were not the case, this percentage would be added to the objective test.	20
Objective test	B1 B5	In the correction of objective tests, the following factors may be taken into account, among other things: - The follow-up of the instructions for its realization. - The technical correctness of the calculations and results. - The order, cleanliness and organization of the delivered material. - The correct expression of the ideas and reasoning used.	60

Assessment comments
The evaluation of the subject will be carried out through the following tests: Activities that can be carried out during the school period: It may be proposed to carry out intermediate tests with a value of up to 20% of the total value of the subject grade (in the case of the proposed carrying out of these, this score may be recoverable through the final objective test).It may be proposed to carry out supervised work with a value of up to 20% of the total value of the subject grade (in the case of the proposed carrying out of these scores it will not be recoverable).Final objective test: Completion of this objective test will be mandatory in order to pass the subject, 40% of the test must be presented and passed correctly in order to add up the score for the activities that can be carried out during the academic period. Depending on the organization or not of the activities during the academic period, the evaluation of the punctuation of the same would be added to the final percentage of the final objective test, which could vary between 60% and 100% of the weighting of the final grade, being necessary to exceed 50% of the test to pass the subject. The assessment method will be similar for the first and second opportunities.Note on the assessment of non-face-to-face activities: Non-face-to-face activities: The teacher will reserve the right to request additional information by video conference in order to validate the veracity of the authorship of the content presented, reserving the right to a reduction of up to 100% of the score obtained in the case of inconclusive answers that may present doubts about the work done . Additional conditions: Condition of not presented: Students who do not present themselves for the first or second opportunity objective test will obtain the status of not presented, regardless of the evaluation of the possible activities carried out during the academic period. Early call: Students who make an early call may retain the score obtained in the activities carried out during the academic period during a call. After this, if the subject has not been passed or no test has been taken, they will be evaluated through a final objective test, scoring it at 100% of the subject's grade, and it is necessary to pass 50% of the test to pass the subject. Academic exemption: Students with an academic dispensation will be exempt from class attendance and laboratory practices. The evaluation methods will be equivalent to those used with students enrolled in the face-to-face mode. Fraudulent performance: Students who fraudulently carry out any type of assessment activity (whether carrying out activities during the academic period or in the objective test), once verified, will automatically be classified as failed (numerical grade 0) in the corresponding call for the academic year, and may not evaluate the subject until the next call for the next academic year.

Sources of information

Basic	- Kothari D. P., Nagrath I. J. (2008). Modern Power System Analysis. McGraw Hill - Saadat H. (2011). Power System Analysis. PSA Publishing LLC - Suárez Creo, Juan M., Andavira (2011). Protección de Instalaciones y Redes Eléctricas. Andavira - Bergen A.R., Vittal V. (1986). Power System Analysis. Prentice-Hall International - Grainger J. J., Stevenson W. D. (1996). Análisis de Sistemas de Potencia. McGraw Hill - Gross C.A. (1986). Power System Analysis. Wiley
Complementary	- Simón Comín P., Garnacho Vecino F. et. Al (2011). Cálculo y diseño de líneas eléctricas de alta tensión. Ibergarceta - Glover, J. D., Sarma M.S., Overbye T. J. (2011). Power System Analysis and Design. Cengage Learning - Barrero F. (2004). Sistemas de Energía Eléctrica. Paraninfo

Recommendations
Subjects that it is recommended to have taken before
Electric Machines I/770G02021 Electric Installations low voltage/770G02022 Electrical power circuits/770G02023 Fisíca II/770G02007 Fundamentos de Electricidade/770G02013
Subjects that are recommended to be taken simultaneously
Electric Machines II/770G02026
Subjects that continue the syllabus
Electric Energy Transport/770G02036
Other comments
To help achieve an immediate sustainable environment and fulfill the objective of action number 5: "Teaching and research that is healthy and environmentally and socially sustainable" of the "Green Campus Ferrol Action Plan":The delivery of the documentary work carried out in this matter:1.1. It will be requested in virtual format and/or computer support.1.2. It will be done through Moodle, in digital format without the need to print them.1.3. If done on paper:- Plastics will not be used- Double-sided printing will be carried out.- Recycled paper will be used.- The printing of drafts will be avoided.In addition to this, the full integration of students who, for physical, sensory, psychological or socio-cultural reasons, experience difficulties in having a suitable, equal and profitable access to university life will be facilitated.