DEGREE CURRICULUM

ELECTRICAL POWER SYSTEMS

Coordination: GREGORIO LOPEZ, EDUARD

Academic year 2023-24

ELECTRICAL POWER SYSTEMS 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>ELECTRICAL POWER SYSTEMS</td></tr>
<tr><td>Code</td><td>102147</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Energy and Sustainability Engineering</td><td>3</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
<tr><td>Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering</td><td>4</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
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<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>GREGORIO LOPEZ, EDUARD</td></tr>
<tr><td>Department</td><td>AGRICULTURAL AND FOREST SCIENCES AND ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>40% at class, 60% autonomous work.
See the "Development plan".</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>English</td></tr>
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ELECTRICAL POWER SYSTEMS 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
DURAN ARANDA, XAVIER	xavier.duran@udl.cat	6,2	
GREGORIO LOPEZ, EDUARD	eduard.gregorio@udl.cat	1	To arrange.

Subject's extra information

This subject is focused on the study of the current electric power systems. In this framework, the components of a power system are presented, calculation of transmission lines are carried out, and the power flow problems is analyzed. On the other hand, the operationf the electrical market is presented and smart grids are introduced. Together with the subject Use of Electrical Energy, it is part of the specifict training about Electrical Energy.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos
Centre the Cultures i Cooperació Transfronterera

http://www.publicacions.udl.cat/

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.
- Keep the laboratoy gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter

between the contact lense and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: http://www.sprl.udl.cat/alumnes/index.html

Learning objectives

This subject is focused on the study of the electrical power systems responsible for the transport and distribution of electrical energy. The specific objectives of this subject are:

- Identify the different components of a power electrical system.
- Calculate the parameters and equivalent circuits in electrical transmission lines.
- Calculate electric transmission lines in permanent regime.
- Analyze the flow in power networks.
- Analyze an electric power distribution system.
- Identify and analyze the structures of the electricity market.
- Recognize and quantify the quality of electric power.
- Identify the elements and applications of smart grids .

Competences

Basic

- CB2. That students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature.
- CB5. That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

General

- CG10.To have knowledge and use of the principles of circuit theory and electrical machines.
- CG11.To have knowledge of the fundamentals of electronics.

Specific

- CE5. To have the capacity to calculate and design electrical machines.
- CE6. To have the capacity to calculate and design low and medium voltage electrical installations.
- CE7. To have the capacity to calculate and design power lines and transport of electrical energy.
- CE8. To have knowledge about electrical power systems and their applications.
- CE9. To have applied knowledge of power electronics.
- CE11. To have the capacity to design power plants.
- CE13. Acquire knowledge and capacity for modeling and simulation of systems.

Cross-disciplinary

- CT2. Master a foreign language, especially English.
- CT3. Acquire training in the use of new technologies and information and communication technologies.

ELECTRICAL POWER SYSTEMS 2023-24

Subject contents

- Unit 1. Electric power systems

  Evolution of modern power system. Electric generation and demand. Description of a modern power system. The per-unit system of measurements.

- Unit 2. Parameters of transmission lines.

  Resistance of conductors. Inductance of conductors. Capacitance of conductors. Parallel-circuit three-phase lines.

- Unit 3. Modelling transmission lines.

  Short transmission line. Medium-length transmission line. Long transmission line. Reactive compensation of transmission lines.

- Unit 4. Power flow

  4.1. Admittance model and network calculation.

  Introduction and fundamentals. Branch and node admittances. The incidence matrix of the network. The method of successive elimination. Triangular factorization.

  4.2. Power flow solutions.

  The problem of power flows. Resolution with numerical methods. Regulating transformers.

- Unit 5. Electric distribution and power quality

  Introduction to technical conditions for the distribution. Distribution actors. Operation of the system. Structure of the distribution network. Power quality problems and regulatory limits. Voltage quality. Harmonic distorsion. Receptors compatibility.

- Unit 6. Electricity markets

  Electricity market organization models. Spanish electricity market. Wholesale electricity market. Network access fees. Contracting electricity supply. The electric bill. Measurement and monitoring equipment. Electric connection rights.

- Unit 7. Smart grids

  Active networks and passive networks. Distributed energy resources. Active management of the ditribution network. Factors for the development of smart grids. The role of energy resources.

- Unit 8. Electric risk

Methodology

- **Lectures:** Classes to explain the theory and problem solving.
- **Resolution of problems:** Students solve problems individually during these sessions under the supervision of the teachers.
- **Delivery of exercises:** Students deliver exercises proposed by the teacher (to solve in class or at home), who corrects and returns it to the student.
- **Simulation:** design and simulation of electric power systems using specific software.
- **Laboratory:** assembly and control of transmission lines using the equipment available in the lab. It is imperative that students take the PPE indicated in each lab class and follow the risk prevention rules specified in each case.
- **Exam:** Two exams are held during the semester. There is also a final retrieval test.

Development plan

The following plan may be subject to change depending on the number of students and the evolution of the group.

Week	Methodology	Contents	Class hours	Hours of autonomous work
1-2	Lectures Resolution of problems	1. Electrical power systems	6	9
2-4	Lectures Resolution of problems	2. Parameters of transmission lines	8	12
4-5	Lectures Resolution of problems	3. Modelling transmission lines	6	9
6-8	Lectures Resolution of problems	4. Power flow	6	12
7	Practices	2. Parameters of transmission lines 3. Modelling transmission lines	2	4
8	Computer practices	4. Power flow	2	6
9	1st exam (PA1)	1. Electrical power systems 2. Parameters of transmission lines 3. Modelling transmission lines 4. Power flow	2	
10-11	Lectures Resolution of problems	5. Electric distribution and power quality	4	8
10-13	Lectures Resolution of problems	6. Electricity market	6	9
13	Practices	6. Electricity market	2	9
14	Lectures Resolution of problems	7. Smart grids	4	6
15	Lectures Resolution of problems	8. Electric risk	4	6
16-18	2nd exam (PA2)	5. Electric distribution and power quality 6. Electricity market 7. Smart grids 8. Electric risk	2	
20-21	Recovery exam	All the contents of the subject	2	

Evaluation

Evaluation blocks	%	Dates
PA 1. Exam (units 1, 2, 3 and 4)	35	Week 9
PA 2. Exam (units 5, 6, 7 and 8)	30	Weeks 16-18
Practices and works	25	Along the course
Exercises	10	Along the course
Recovery exam	65	Week 20-21

Guidelines for evaluation of the subject.

- To pass the course it is necessary at least a grade of 5 over 10 of the final grade.

Exams:

- In the 9th and 16-18th weeks the scheduled exams will be performed (PA1 and PA2). Exam PA1 has a weight of 35% and exam PA2 has a weight of 30% over the final grade of the course.
- The scheduled exams (PA1 and PA2) can be recovered by completing an exam of each part or a joint exam of both parts (20-21th week).

Practices and exercises

- The practices, works and exercises grades can not be recovered by performing other recovery activities.

Alternative evaluation.

- The student who is granted the option of alternative evaluation must take an exam where all the contents of the subject will be assessed. This exam will be held on the date set for the PA2 exam in the school's exam calendar. This exam has a weight of 87.5% over the final grade of the course. This exam can be recovered by taking a recovery exam on the date set in the school's exam calendar.
- The student who is granted the option of alternative evaluation must also attend a laboratory practice session and a simulation practice session that will take place throughout the course and must deliver the reports corresponding to these sessions. Attendance at theses practices and delivery of the corresponding reports has a weight of 12.5% over the final grade of the course.The practice grade cannot be recovered by performing other recovery activities.

Bibliography

Basic bibliography

- John Grainger, Jr. William Stevenson, Gary W. Chang, 2015. *Power System Analysis.* 2nd edition, McGraw-Hill.
- Fermín Barrero González, 2004. *Sistemas de Energía Eléctrica.* Ed. Paraninfo. 380 pp.

Complementary bibliography

- José María Yusta Loyo, 2013. *Contratación del suministro eléctrico.* Ed. Paraninfo. 168 pp.
- J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, 2016. *Power System Analysis and Design.* Ed. Cengage Learning. 864 pp.