DEGREE CURRICULUM

ENERGY FACILITIES III

Coordination: MEDRANO MARTORELL, MARCO

Academic year 2023-24

ENERGY FACILITIES III 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>ENERGY FACILITIES III</td></tr>
<tr><td>Code</td><td>102313</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>4</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
<tr><td>Bachelor's Degree in Mechanical Engineering</td><td>4</td><td>OPTIONAL</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>5</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
</table>
</td></tr>
<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>3</td><td>3</td></tr>
<tr><td>Number of groups</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>Coordination</td><td>MEDRANO MARTORELL, MARCO</td></tr>
<tr><td>Department</td><td>INDUSTRIAL AND BUILDING ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>60 h of lectures (40%)
90 h independent student work (60%)</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>
<tr><td>Distribution of credits</td><td>Dr. Marc Medrano Martorell 3,6 ECTS
Josep Eras 3,6 ECTS</td></tr>
</table>

ENERGY FACILITIES III 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
ERAS VILA, JOSEP ANTONI	josep.eras@udl.cat	3,6	
MEDRANO MARTORELL, MARCO	marc.medrano@udl.cat	0	
MEDRANO MARTORELL, MARCO	marc.medrano@udl.cat	3,6	

Subject's extra information

This course requires continuous work throughout the semester in order to achieve the established goals. It is recommended to visit frequently the Virtual Campus subject, because it announces all the information in it. This subject belongs to the module "Optatisysve Subjects", specifically in the field "Energy Facilities". We recommend using direct mail instead of the Messaging options via the Virtual Campus. There are no prerequisites for this course, but a basic knowledge of thermodynamic power cycles and heat transfer are recommended.
The flippled classroom methodology is used in this subject to facilitate the work of problems, project and difficult concepts in class.

Throughout the course, **Equation Engineering Solver (EES)** software will be used for a comprehensive project. It is a simple but very useful program for solving equations and for calculating thermodynamic properties of fluids.

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

- Blue or white 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

- To be able to search, understand and synthesize information in a foreign language.
- To provide students with the basic knowledge to analyse energy systems from different points of view, energy, the economic and exergetic.
- To introduce students to energy systems for capturing solar radiation.
- To understand in detail a power plant with renewable energy.
- To strengthen the previous study using the flipped classroom methodology.
- To understand in practice the elements and operation of an installation of solar thermal collectors of low temperature.

Competences

- **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.
- **CB4**. That students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
- **EPS4/CB5**. That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.
- **CB5**. That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.
- **CG6**. Have adequate knowledge of the concept of the company, the institutional and legal framework of the company and the organization and management of companies.
- **CG15**. Have basic knowledge of production and manufacturing systems.
- **CG16**. To have basic knowledge and application of environmental technologies and sustainability.
- **CG17**. Have applied knowledge of business organization.
- **CE2**. Have applied knowledge of thermal engineering.
- **CE3**. Have applied knowledge of the fundamentals of fluid-mechanical systems and machines.
- **CE12**. To have applied knowledge about renewable energies.
- **CE15**. To acquire the ability to understand, interpret and apply the legislation on energy and environment.
- **CE16**. Acquire capacity to assess the impacts of energy resources through knowledge of the

naturalenvironment and conduct energy and environmental audits.

- **UdL2/CT2**. Master a foreign language, especially English.
- **CT3**. Acquire training in the use of new technologies and information and communication technologies
- **CT4**. To acquire basic knowledge of entrepreneurship and professional environments.
- **EPS9**. Capacity for unidisciplinary and multidisciplinary teamwork.
- **GEM-EPS31**. Capacity to design HVAC installations (heating, ventilation and air conditioning).
- **GEM-EPS32**. Applied knowledge to distributed energy generation and energy use.
- **GEM-EPS33**. Capacity of analysis of energy systems, optimization and integration.

Subject contents

1. Introduction

1.1 Energy situation in Catalonia, Spain and worldwide

1.2 Impact of CO_2 emissions and emissions rights

1.3 Sequestering of CO_2

2. Energy analysis

2.1 Mass balances with no chemical reaction

2.2 Mass balance with chemical reaction

2.3 Energy analysis of cogeneration plant

3. Exergy analysis

3.1 Introduction to exergy concept

3.2 Exergy components

3.3 Exergy analysis of cogeneration plant

4. Economic Analysis

4.1 Investment estimates

4.2 Profitability indicators

5. Solar thermal installations

5.1 Solar radiation

5.2 Solar thermal energy

Methodology

The methodology used in this subject combines inquiry-based learning with Flipped Learning. The methodological axes of the subject will be divided into:

1.-Reverse class activities prior to class attendance: for each topic students must complete a reverse class activity through the virtual campus.

2.-Theoretical-practical sessions: discussion of doubts and misconceptions of reverse class activities. Introduction

of new concepts and practical activities.

3.-Problem sessions: the teacher will make some examples but where students will take an active part in their learning process.

4.-Practical sessions in the laboratory and for the integral project.

Development plan

The development plan will follow the order of the contents.

Week	Methodology	Topic	Lecture Hours	Autonomous work hours
1	Master class	Subject presentation, Intro to EES.	4	6
2-5	Flipped classroom. Resolution of problems Lab practice	5. Solar thermal installations and and project practical sessions. Solar collectors lab practice.	14	21
5	Visit	Visit to Borges thermal power plant	2	3
6-8	Flipped classroom Resolution of problems.	1. Introduction 2. Energy analysis and project practical sessions.	12	18
9		Evaluación. Prueba escrita.	2	3
10-12	Flipped classroom Resolution of problems.	3. Exergy analysis and project practical sessions.	12	18
13-15	Flipped classroom Resolution of problems.	4. Economic analysis and project practical sessions.	10	15
15	Oral presentations	Project oral presentations	2	3
16-19		Evaluation. Written Test. Recovery	2	3

Evaluation

EVALUATION BLOCK 1 (15%): PRIMER PARCIAL

- *EVALUATION ACTIVITY 1*: FIRST PARTIAL EXAM (individual activity)

- WEIGHT IN THE FINAL GRADE: 15%
- MINIMUM GRADE NECESSARY TO PASS THE SUBJECT: 3

EVALUATION BLOCK 2 (50%): PROJECT ABOUT INTEGRAL PROJECT

- *EVALUATION ACTIVITY 2:* ORAL PRESENTATION OF THE PROJECT (oral individual activity)

- WEIGHT IN THE FINAL GRADE: 25%

- *EVALUATION ACTIVITY 3:* DELIVERY DOSSIER PROJECT (group activity)

- WEIGHT IN THE FINAL GRADE: 25%

EVALUATION BLOCK 3 (15%): SECOND PARTIAL EXAM

- *EVALUATION ACTIVITY 4*: SECOND PARTIAL EXAM (individual activity)

- WEIGHT IN THE FINAL GRADE: 15%
- MINIMUM GRADE NECESSARY TO PASS THE SUBJECT: 3

EVALUATION BLOCK 4 (20%): FLIPPED LEARNING FOLLOW-UP (individual activity)

- *EVALUATION ACTIVITY 5: OPEN QUESTIONS*

- WEIGHT IN THE FINAL GRADE: 5%

- *EVALUATION ACTIVITY 6: TEST QUESTIONS*

- WEIGHT IN THE FINAL GRADE: 10%

- *EVALUATION ACTIVITY 7: SOLAR COLLECTOR PRACTICE*

- WEIGHT IN THE FINAL GRADE: 5%

There will be recovery only of the 2 individual written exams. In order to make the average at the end of the course, the mark in the partial exams must be >= 3,0 points.

In the event that the student does not achieve the minimum necessary qualification established in some of the evaluation blocks but the average for the subject is approved, the subject will be graded in the evaluation report with a 4,9.

ALTERNATIVE EVALUATION

Students who opt for the alternative assessment must carry out the following activities:

EVALUATION BLOCK 1 (30%): FIRST PARTIAL EXAM

- *EVALUATION ACTIVITY 1*: FIRST PARTIAL EXAM (individual activity)

- WEIGHT IN THE FINAL GRADE: 30%

- MINIMUM GRADE NECESSARY TO PASS THE SUBJECT: 3

EVALUATION BLOCK 2 (40%): PROJECT ABOUT INTEGRAL PROJECT

- *EVALUATION ACTIVITY 3:* DELIVERY DOSSIER PROJECT (individual activity)
- WEIGHT IN THE FINAL GRADE: 40%

EVALUATION BLOCK 3 (30%): SECOND PARTIAL EXAM

- *EVALUATION ACTIVITY 4*: SECOND PARTIAL EXAM (individual activity)

- WEIGHT IN THE FINAL GRADE: 30%
- MINIMUM GRADE NECESSARY TO PASS THE SUBJECT: 3

There will be recovery only of the 2 individual written exams. In order to make the average at the end of the course, the mark in the partial exams must be >= 3,0 points.

In the event that the student does not achieve the minimum necessary qualification established in some of the evaluation blocks but the average for the subject is approved, the subject will be graded in the evaluation report with a 4,9.

Bibliography

References

- Adrian Bejan, 'Thermal Design Optimization', 1996. Ed. John Wiley & Sons, Inc. ISBN: 0-471-58467-3
- Robert F. Boehm, 'Developments in the Design of Thermal Systems', 1997, Ed. Cambridge University Press. ISBN: 0-521-46204-5
- Tadeusz J. Kotas, 'The Exergy Method of Thermal Plant Analysis', 1985, Ed. Butterworth. ISBN: 0-408-01350-8
- Yogesh Jaluria, 'Design and Optimization of Thermal Systems', 1998
- Gintaras V.Reklaitis, 'Balances de Materia y Energía', 1986, Nueva Editorial Interamericana. ISBN: 968-25-1146-1
- John F. Ahern, 'The Exergy Method of Energy Systems Analysis', 1980, Ed. John Wiley & Sons, Inc.
- Enrique Buatas Costa, 'Manual de Conservación de la Energía', Ed. Gestión y Planificación Integral, S.A. ISBN: 8-485-82700-7
- Luisa F. Cabeza, Marc Medrano, Ingrid Martorell, 'Gestió de sistemes energètics – Fred i calor industrial –', Quaderns EPS
- Luisa F. Cabeza, Ingrid Martorell, 'Producció de l'energia tèrmica – Fred i calor industrial –', Quaderns EPS - Núm. 93.
- ENERGÍA SOLAR FOTOVOLTAICA Y TÉRMICA. MANUAL TÉCNICO, Inma C. Castillo, Javier M. Cenzano, Eva Esteire y Antonio Madrid Vicente, AMV Ediciones, 2020, ISBN/EAN: 9788412095487.