Course guides
820745 - EGT - Geothermal Energy

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 724 - MMT - Department of Heat Engines.
Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).
Academic year: 2020 ECTS Credits: 5.0 Languages: Catalan, Spanish

LEcTuReR
Coordinating lecturer: Felipe Blanch, Jose Juan De
Others: Felipe Blanch, Jose Juan De

PRIOl R SKILLS
Fundamentals of Heat Transfer
Fundamentals of Thermodynamics
Fundamentals of Fluid Mechanics

REQUIREMENTS
Thermal Equipment

DEGREE COMPETENCES TO WHICH THE SUBJECT CONtributes
Specific:
CEMT1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.
CEMT4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.
CEMT5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.
CEMT7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.
TEACHING METHODOLOGY

The course teaching methodologies are as follows:

- Lectures and conferences: knowledge exposed by lecturers or guest speakers.
- Practical sessions: resolution of exercises, debates and group dynamics, with the lecturer and other students in the classroom; classroom presentation of an activity individually or in small groups.
- Laboratory / Workshop: completion of designs, measurements, verifications, etc.; and presentation of results orally or in writing individually or in small groups.
- Theoretical/practical supervised work: classroom activity, carried out individually or in small groups, with the advice and supervision of the teacher.
- Homework assignment of reduced extension: carry out homework of reduced extension, individually or in groups.
- Homework assignment of broad extension (PA): design, planning and implementation of a project or homework assignment of broad extension by a group of students, and writing a report that should include the approach, results and conclusions.

Training activities:

The course training activities are as follows:

Face to face activities

- Lectures and conferences: learning based on understanding and synthesizing the knowledge presented by the teacher or by invited speakers.
- Participatory sessions: learning based on participating in the collective resolution of exercises, as well as in discussions and group dynamics, with the lecturer and other students in the classroom.
- Presentations: learning based on students presenting in the classroom an activity individually or in small groups.
- Laboratory / Workshop: learning based on students understanding the operation of equipment, their specifications and documentation; making designs, measurements, verifications, etc.; and presenting results orally or in writing, individually or in small groups.
- Theoretical/practical supervised work: learning based on performing an activity in the classroom with the advice of the teacher.

Study activities

- Homework assignment of reduced extension: learning based on applying knowledge and presenting results.
- Homework assignment of broad extension: learning based on applying and extending knowledge.
- Self-study: learning based on studying or expanding the contents of the learning material, individually or in groups, understanding, assimilating, analysing and synthesizing knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

Objectives

- Understanding the potential use of geothermal energy and its environmental impacts
- Understanding, domain and application of technologies associated with the use of low enthalpy geothermal
- Understanding and mastery of other geothermal technologies use

Learning Outcomes

At the end of the course, he / student:

* Understand the role of geothermal energy in the context of global and regional energy system, its economic, social and environmental connotations, and the impact of technologies on a local and global context.
* Meet relevant organizations, major projects internationally, the main sources of information and policy related to geothermal technology.
* They have the elements of analysis and knowledge necessary to carry out a project, basic engineering scale, related to the quality and / or supply of energy using geothermal technology.
* Know the major lines of research in the field of geothermal utilization technologies and is able to bring innovative ideas.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>85,0</td>
<td>68.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>10,0</td>
<td>8.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>30,0</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

1. Introduction to geothermal energy

Description:
Geothermal energy source. Ranking. Potential geothermal resources at global, national and regional level. Organizations and associations.

Specific objectives:
What the student understands the scope and potential of geothermal energy

Related activities:
0. Do a “puzzle”

Related competencies:
CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

Full-or-part-time: 8h
Theory classes: 1h
Practical classes: 1h
Guided activities: 2h
Self study: 4h
### 2. Basement, subsurface thermal properties

**Description:**

**Specific objectives:**
What the student understands and can interpret the mechanical-thermal characteristics of the ground

**Related activities:**
1. Test

**Related competencies**:
CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

**Full-or-part-time**: 29h
- Theory classes: 4h
- Practical classes: 4h
- Guided activities: 4h
- Self study: 17h

### 3. Low enthalpy geothermal systems

**Description:**
Classification of low enthalpy geothermal systems. Vertical and horizontal geothermal probes. Geothermal heat pumps. Geothermal heating

**Specific objectives:**
What the student understands, knows and analyze the application of low enthalpy geothermal systems.

**Related activities:**
1. Test
2. Project of low enthalpy geothermal

**Related competencies**:
CEMT-5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.
CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

**Full-or-part-time**: 39h
- Theory classes: 4h
- Practical classes: 4h
- Guided activities: 4h
- Self study: 27h
4. Geothermal systems of medium and high enthalpy

Description:
Classification of geothermal systems of medium and high enthalpy. Geothermal plants

Specific objectives:
What the student understands, knows and analyze the application of geothermal systems of medium and high enthalpy

Related activities:
1. Test

Related competencies:
CEMT-5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.
CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

Full-or-part-time: 23h
Theory classes: 3h
Practical classes: 3h
Guided activities: 4h
Self study : 13h

5. Underground thermal energy storage

Description:
Systems underground thermal energy storage

Specific objectives:
What the student understand and be able to assess the implementation of systems underground thermal energy storage

Related activities:
1. Test

Related competencies:
CEMT-5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.
CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

Full-or-part-time: 15h
Theory classes: 2h
Practical classes: 2h
Guided activities: 2h
Self study : 9h
6. Environmental impacts and legislation

**Description:**
Potential environmental impacts of technologies harnessing geothermal energy. legislation

**Specific objectives:**
What the student understand and be able to assess the potential environmental impacts of technologies using geothermal energy. Know the law on these types of exploitation.

**Related activities:**
1. Test
3. Written test

**Related competencies:**
CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

**Full-or-part-time:** 11h
Theory classes: 1h
Practical classes: 1h
Guided activities: 2h
Self study : 7h

### ACTIVITIES

**0. Puzzle**

**Description:**
Making a type "Puzzle" cooperative learning activity on "Introduction of geothermal energy"

**Specific objectives:**
CEMT1

**Material:**
Available in digital campus

**Delivery:**
Handwritten document with the general ideas

**Related competencies**:
CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

**Full-or-part-time:** 1h
Practical classes: 1h
1. Test

**Description:**
Performing a test on theory subjects 2 to 6

**Specific objectives:**
CETM1, CETM4 and CETM7

**Material:**
Test on the digital campus.

**Delivery:**
Test responses in the digital campus

**Related competencies:**
CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

**Full-or-part-time:** 6h
Guided activities: 1h
Self study: 5h

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2. Project of low enthalpy geothermal energy

**Description:**
Develop a small project to implement low temperature geothermal energy

**Specific objectives:**
CETM4, CTM6 and CETM7

**Material:**
Design data, geographical location, type of technology to use

**Delivery:**
Project report at the end of the 10th week of the course

**Related competencies:**
CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

CEMT-5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.

**Full-or-part-time:** 14h
Guided activities: 4h
Self study: 10h
### 3. Written test

**Description:**
Making a written test troubleshooting

**Specific objectives:**
All competencies

**Material:**
Statements problems and calculator

**Delivery:**
Results of the problems solved. End of the 15th week of the course

**Related competencies:**
CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

CEMT-5. Employ technical and economic criteria to select the most appropriate thermal equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technological applications in the production, transportation, distribution, storage and use of thermal energy.

CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

**Full-or-part-time:** 18h
- Theory classes: 2h
- Self study: 16h

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**GRADING SYSTEM**

**BIBLIOGRAPHY**

**Basic:**

**Complementary:**

**RESOURCES**

**Other resources:**
Presentations and other documents in digital campus