220211 - Energy Technology

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 724 - MMT - Department of Heat Engines
Academic year: 2019
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Teaching unit Compulsory)
ECTS credits: 5
Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Yolanda Calventus
Others: Lluís Miquel Domènec, Gustavo Rausch, Ivette Rodríguez, Joaquim Rigola

Prior skills


Degree competences to which the subject contributes

Specific:
1. Knowledge and skills for the design and analysis of heat engines and machines, hydraulic machines and installations of heating and cooling industry.
2. Have adequate knowledge of the scientific and technological aspects of: mathematical methods, analytical and numerical engineering, electrical engineering, energy engineering, chemical engineering, mechanical engineering, continuum mechanics, electronics, industrial automation, manufacturing, materials, quantitative methods management, industrial computing, urban planning, infrastructure, etc..
3. Student capacity to use their knowledge in new and multidisciplinary situations.
5. Knowledge and skills to plan and design electrical and fluid, lighting, air conditioning and ventilation, energy saving and efficiency, acoustics, communications, home automation, intelligent buildings and facilities security.
7. Knowledge and skills for understanding, analyzing, managing and exploiting different sources of energy.
220211 - Energy Technology

Teaching methodology

The course is organized:
1. Classes in large groups. These classes in the theory classes, some classes of problems develop and assessments for the first and second exams. Expository method is that the teacher considers more suitable to achieve the objectives in the course. Problems were also solved.
2. Classes in medium groups: In these classes will carry out laboratory classes and also sessions for solving problems that the teacher proposed to the students for their resolution and they are a part of autonomous learning. ATENEA support platform is used in the two types of classes as described. It will be used as transmitter and communicator with students.
   a) Teacher to students:
      1. Scheduling activities and information
      2. Learning Material
      3. Assessment activities
   b) Student to teachers:
      1. Questions and comments
   c) Between Students
      1. Use the FORUM as a place for information and discussion

Learning objectives of the subject

- Acquire in-depth knowledge of the different sources of renewable and non-renewable energy.
- Ability to obtain usable energy with maximum energy efficiency and minimum environmental impact possible.
- Acquire the ability to work with methods and technologies for the efficient use of energy based on thermodynamic criteria.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 30h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 15h</td>
<td>12.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Content 1: Energy efficiency in industry</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>1.2 Review of the CHP concept</td>
<td>Self study: 10h</td>
</tr>
<tr>
<td>1.3 Parameters of efficiency cogeneration</td>
<td></td>
</tr>
<tr>
<td>1.4 Energy savings</td>
<td></td>
</tr>
<tr>
<td>1.5 Plants matched to power and heat demands</td>
<td></td>
</tr>
<tr>
<td>1.6 Cogeneration Technologies</td>
<td></td>
</tr>
</tbody>
</table>

| Related activities:                   |                       |
| Theory/large sessions and exercises/medium sessions |                       |
| Report of the subject                 |                       |

| Specific objectives:                  |                       |
| - Give an overview of the energy efficiency in industry energy and primary energy saving |                       |
| - Define cogeneration and its main applications in the secondary and tertiary sectors |                       |
| - Apply to practical problems and evaluate the different efficiency criteria in cogeneration and discern what plant will be the most suitable to install. |                       |
| - Calculate for each type of plant the energy saving, according to the different electrical or thermal adjustings. |                       |

<table>
<thead>
<tr>
<th>Content 2: Exergy and Thermoeconomical Analysis of power plants</th>
<th>Learning time: 26h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>2.1 Introduction: exergy analysis</td>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>2.2 Flow exergy</td>
<td>Self study: 17h</td>
</tr>
<tr>
<td>2.3 Exergy rate balance for control volumes at steady state. Determining exergy destruction</td>
<td></td>
</tr>
<tr>
<td>2.4 Fuel chemical exergy</td>
<td></td>
</tr>
<tr>
<td>2.5 Exergy parameters for evaluating plants: Exergetic efficiency. Exergy analysis diagrams</td>
<td></td>
</tr>
<tr>
<td>2.6 Destroyed exergy Percentage</td>
<td></td>
</tr>
<tr>
<td>2.7 Availability efficiency criteria in CHP plants</td>
<td></td>
</tr>
<tr>
<td>2.8 Thermoeconomical analysis</td>
<td></td>
</tr>
</tbody>
</table>

| Related activities:                                           |                       |
| Theory/large sessions and exercises/medium sessions            |                       |

| Specific objectives:                                          |                       |
| - Apply the exergy analysis for improving the power plants    |                       |
| - Evaluating criteria                                        |                       |
### Content 3: Biomass

**Learning time:** 7h  
Theory classes: 2h  
Self study: 5h

**Description:**  
3.1 What is Biomass  
3.2 Sources of Biomass  
3.3 Classification of Biomass  
3.4 Biomass transformation processes

**Related activities:**  
Theory classes  
Report of the subject

**Specific objectives:**  
Learn the fundamental characteristics of biomass and its transformation processes

### Content 4: Solar energy

**Learning time:** 18h  
Theory classes: 4h  
Practical classes: 2h  
Self study: 12h

**Description:**  
4.1 Introduction to solar thermal energy. Theoretical background. Solar-energy concepts.  
4.2 Solar thermal systems in buildings and their equipment.  
4.3 Flat-plate collectors. Efficiency of a flat-plate collector.  
4.4 Thermal energy storage for solar thermal systems.  
4.5 Characterisation and performance of a low-temperature solar thermal system.  

**Related activities:**  
Theory/large sessions and exercises/medium sessions.  
Report of the subject

**Specific objectives:**  
- To know the main techniques used in solar thermal energy and their role in energy efficiency in buildings.
## Contents

### Content 5: Thermal energy storage

**Description:**
5.1 Introduction to thermal energy storage (TES) in buildings. Role of TES.  
5.2 Main techniques and characteristics. Integration of TES in buildings: seasonal heat storage, massive storage, cool storage. Performance and evaluation of TES.

**Related activities:**
Theory/large sessions and exercises/medium sessions  
Report of the subject

**Specific objectives:**
Introduction to thermal storage techniques and their integration in buildings

### Content 6: Solar thermal electricity

**Description:**
6.1 Introduction to concentrated solar power (CSP).  
6.2 Main advantages of CSP plants. Main technologies and characteristics.  
6.3 Examples of CSP plants.  
6.4 Performance and evaluation of a CSP plant.

**Related activities:**
Theory/large sessions and exercises/medium sessions  
Report of the subject

**Specific objectives:**
To know the main techniques for solar thermal electricity and how it works.
## Content 7: Hydroelectric and wind energy

### Description:
- 7. Hydroelectric and wind generation
- 7.1 Hydroelectric generation
  - 7.1.1 Introduction. Hydropower potential.
  - 7.1.3 Water resources. Discharge measurements. Runoff coefficient.
  - 7.1.4 Hydraulic Structures. Dams.
  - 7.1.5 Electromechanical equipment. Hydraulic turbines.
  - 7.1.6 Environmental impact.

- 1.2 Wind energy
  - 1.2.1 Introduction.
  - 1.2.1.1 Advantages of wind power.
  - 1.2.1.2 History of wind power use.
  - 1.2.2 Wind power exploitation
    - 1.2.2.1 Nature and types of wind.
    - 1.2.2.2 Wind power (and power of a wind turbine)
    - 1.2.2.3 Performance. Betz Limit
    - 1.2.2.4 Variability of the wind speed
    - 1.2.2.5 Power curve of a wind turbine

### Related activities:
- Theory/large group sessions and practical/medium group sessions.
- Laboratory experiment

### Specific objectives:
- Ability to analyze the behavior of a hydroelectric plant and evaluate the variables involved in the calculation thereof potential
- Ability to perform a fluid dynamic and energetic study of a wind system

### Learning time:
- Theory classes: 3h
- Practical classes: 2h
- Self study: 10h
### Content 8: Geothermal Energy

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 15h</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Geothermal Energy.</td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>8.1.1. The Earth's crust.</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>8.1.2. Evolution of the Earth's crust.</td>
<td>Self study: 10h</td>
</tr>
<tr>
<td>8.1.4. Energy transport in geothermal systems</td>
<td></td>
</tr>
</tbody>
</table>

8.2 Geothermal systems: general characteristics  
8.2.2. Geochemistry of geothermal fluids.  
8.2.3. Geothermometers.

8.3 Exploitation of geothermal systems  
8.3.1. Features of the exploited geothermal systems.  
8.3.2. Exploitation of Geothermal Energy.  
8.3.3. Types of Geothermal Power Plants.  
8.3.4. Environmental impact of geothermal exploitation.

### Related activities:
Theory/large sessions and practical/medium sessions.  
Laboratory experiment

### Specific objectives:
- Ability to analyze the behavior of a geothermal system  
- Ability to evaluate the behavior of a fossil fuel power station and its environmental impact
# Planning of activities

<table>
<thead>
<tr>
<th>ACTIVITY 1: THEORY CLASSES</th>
<th>Hours: 61h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 26h</td>
</tr>
<tr>
<td></td>
<td>Self study: 35h</td>
</tr>
</tbody>
</table>

**Description:**
- Large group methodology
- Expository and participatory classes
- The subject is organized in 8 different contents
- Exercises will be solve with the large group

**Support materials:**
- Basic bibliography
- Lecture notes (available in ATENEA)
- List of proposed exercises (ATENEA)

**Descriptions of the assignments due and their relation to the assessment:**
Activity 1 and activity 2 will be both evaluated in first and second partial exams.

**Specific objectives:**
At the end of this activity, the student should be able to master the skills worked, consolidate and correctly apply them to problems involving real situations.

<table>
<thead>
<tr>
<th>ACTIVITY 2: EXERCISES CLASSES</th>
<th>Hours: 29h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 11h</td>
</tr>
<tr>
<td></td>
<td>Self study: 18h</td>
</tr>
</tbody>
</table>

**Description:**
- Medium group methodology
- For each content, problems will be solved in class for students to acquire the necessary guidelines to carry out this resolution

**Support materials:**
- Basic bibliography
- Teacher notes (ATENEA)
- List of proposed exercises (ATENEA)

**Descriptions of the assignments due and their relation to the assessment:**
Activity 1 and activity 2 will be both evaluated in first and second partial exams.

**Specific objectives:**
After completing this activity, students should be able to apply theoretical knowledge to solving real technical problems.

<table>
<thead>
<tr>
<th>ACTIVITY 3: PRACTICAL CLASSES</th>
<th>Hours: 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 1h</td>
</tr>
</tbody>
</table>
Description:
Medium group methodology
For contents 7 and 8, laboratory experiments or computational practice will be carried out

Support materials:
Basic Bibliography
Lecture Notes (ATENEA)
Statement of activity

Descriptions of the assignments due and their relation to the assessment:
A report of this activity will be given to evaluate
The rating practices (NL) will be 15% of the overall course grade

Specific objectives:
Upon completion of this activity students should be able to:
- Deal with experimental data and draw conclusions
- Prepare a report of the work done

ACTIVITY 4: FIRST PARTIAL EXAM

| Hours: 9h |
| Theory classes: 2h |
| Self study: 7h |

Description:
Development of the partial examination of the subject of contents explained during this period
It includes theoretical and practical aspects
The students who pass this exam can remove theses contents

Support materials:
Statement papers

Descriptions of the assignments due and their relation to the assessment:
The hand-in will be the result of the exam.
It represents 30% of the final course grade

Specific objectives:
The exam must demonstrate that the student has acquired and assimilated the concepts and fundamentals related to the corresponding contents

ACTIVITY 5: SECOND PARTIAL EXAM

| Hours: 12h |
| Theory classes: 2h |
| Self study: 10h |

Description:
Individual and writing assessment about the contents explained during the corresponding period
The exam is theoretical and practical (solving exercises)
In this exam it will be established the mechanism to redirect students who have not passed the first partial exam.

Support materials:
Statement papers
ACTIVITY 6: Report of the subject

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students in groups of 3 or 4 will select, in agreement with professors, a report title that should develop from a list proposed by professors. This report must follow an scheme which will be discussed and fixed conveniently by professors.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study: 9h</td>
</tr>
</tbody>
</table>

Specific objectives:
The aim of this activity is students delve into a topic of the subject that has a special interest for them. It also seeks to promote discussion among members of the group, to learn how to structure and develop the report and how to manage the information resources.

Qualification system

- First partial exam N1P: 30%
- Second partial exam N2P: 40%
- Activities (Laboratory) NL: 15%
- Subject report NT: 15%

In the second partial exam it will be established he mechanism to redirect students who have not passed the first partial exam.

Regulations for carrying out activities

1 -. First partial exam will be made without using books, notes or other teaching material except Book of Tables and Charts, and occasionally made a form that each student will do if the teacher says.
2 -. Concerning practices report students will deliver a report to the teacher
Bibliography

Basic:


Others resources:

Hyperlink

www.energiza.org
220211 - Energy Technology

www.acogen.es

www.gencat.cat/icaen/

Computer material
Apunts de l'assignatura Tecnologia Energètica, mòdul d'Energia Solar Tèrmica