240EQ012 - Energy Technology

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2017
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Compulsory)
MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Compulsory)
ECTS credits: 4,5  Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Blas Del Hoyo, Alfredo De
Others: Blas Del Hoyo, Alfredo De

Prior skills
Basic knowledge of physics, chemistry, thermodynamics and heat engines and machines.

Degree competences to which the subject contributes

Specific:
1. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

Generical:
2. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.

Transversal:
3. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
5. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology
MD2: Lectures
MD3: Self study
MD4: Cooperative learning

Learning objectives of the subject
- Show students the current methods and development to make the most of the different energy sources.
- Understand the physics and technology basics of conversion, storage and transportation, and energy uses.
- Make the student to be aware of the social-economic implications and environmental transformation and use of energy (energy management).
### Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 27h 24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h 0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 13h 30m 12.00%</td>
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<tr>
<td></td>
<td>Guided activities: 0h 0.00%</td>
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<tr>
<td></td>
<td>Self study: 72h 64.00%</td>
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</table>
## Content

### 1. Introduction to the energetic problem

**Learning time:** 7h
- Theory classes: 2h
- Practical classes: 2h
- Self study: 3h

**Description:**
Energetic resources, energetic structure, definition of units, forms of energy, previous basic concepts, primary energy, final energy.

**Related activities:**
A1, A2, A5, A6

**Specific objectives:**
- OE1.1: Define reserves and resources and evaluate the current situation of the main fuels.
- OE1.2: Analyse statistical data of reserves, production and consumption and draw conclusions out of them.
- OE1.3: Define the concept of primary energy, secondary and final energy and its relation.
- OE1.4: Perform and analyse flow diagrams and energetic balances.
- OE1.5: Explain the relation between the energy consumption of a country and its economic activity through parameters such as energy intensity.

### 2. Energy transformation

**Learning time:** 4h
- Theory classes: 1h
- Practical classes: 1h
- Self study: 2h

**Description:**
The deterioration of energy in the processes, energy conversion systems, energy storing systems, exergy.

**Related activities:**
A1, A2, A5, A6

**Specific objectives:**
- OE2.1: Explain the problem of energy deterioration and relate it to the concept of exergy.
- OE2.2: List some of the major existing energy converters, describe its key attributes and compare them in base to its efficiency.
- OE2.3: List some of the major energy storage systems.
### 3. Fossil fuels

**Description:**
Origin, composition, Combustion reactions with and without excess of air, quantification of the formation of combustion products, current applications, thermal power plants (steam), combined-cycle power plants, environmental impact, prospects for the future

**Related activities:**
A1, A2, A4, A5, A6

**Specific objectives:**
OE3.1: Describe the main characteristics of the fossil fuels and the combustion process
OE3.2: Solve practical cases determining the composition of the smoke generated and the temperature of combustion
OE3.3: Describe the main characteristics of the production, transport and distribution of the fossil fuels
OE3.4: Describe some of the main technologies and equipment related to the use of coal, oil and natural gas. Apply what has been taught in class to the study of practical cases
OE3.5: Describe the legislative frame regulating the environmental impact of the facilities using these fuels and apply it to solve practical exercises

**Learning time:** 24h  
Theory classes: 8h  
Practical classes: 7h  
Self study: 9h

### 4. Nuclear Fission Energy

**Description:**
Origin, basic concepts of the atomic and nuclear physics, radioactivity, nuclear reactions, nuclear fission, nuclear power plants, nuclear security, new trends.

**Related activities:**
A1, A2, A4, A5, A6

**Specific objectives:**
OE4.1: Describe the nuclear reactions which can be useful in order to obtain energy
OE4.2: Describe the fission reaction, its main characteristics and reason the interest of the chain fission reaction in order to obtain energy
OE4.3: Define radioactivity and describe the general way of its processes and its impact on the technology of the nuclear power plants (waste potential, waste)
OE4.4: Compare a convetional thermal power plant to a nuclear plant
OE4.5: Solve practical exercises about nuclear power plants.
OE4.6: Number the main types of reactors, explaining its elements and its main characteristics from an operational and security point of view
OE4.7: Describe the combustion cycle and the problem with its final stage: waste.OE4.8: Value the situation of Spain in the global nuclear industry
OE4.9: Reason about the environmental impact of the use of this energy

**Learning time:** 14h  
Theory classes: 4h  
Practical classes: 4h  
Self study: 6h
### 5. Renewable energies

**Description:**
Description of the renewable energies, hydroelectric energy, solar thermal and thermoelectric power, photovoltaic solar power, wind energy, bioenergy, use of hydrogen as an energy carrier.

**Related activities:**
A1, A2, A3, A5, A6

**Specific objectives:**
- OE5.1: Describe the possible locations, applications and layout of the elements for a hydroelectric, solar or wind use, as well as the main characteristics of this elements.
- OE5.2: Describe the main characteristics of other non conventional renewable sources (geothermal, biomass) and number some of its main applications
- OE5.3: Solve practical exercises about applications facilities of renewable sources
- OE5.4: Value the importance of these sources from an economical and environmental point of view

**Learning time:** 17h
- Theory classes: 4h
- Practical classes: 6h
- Self study: 7h

### 6. Electrical sector

**Description:**
Activities and structure of the electric sector, generation of electric power (power and energy) demand coverage, liberalization of the sector.

**Related activities:**
A1, A2, A5, A6

**Specific objectives:**
- OE6.1: Define the electric sector, numbering its main objectives and activities.
- OE6.2: Describe the main characteristics of the structure of the electric power demand, of the generation (normal and special regime) and the transport and argue about the need to program the production and encourage the self-producers of energy
- OE6.3: Explain the structure of costs of the electrical system and the methodology of the tax rate in Spain
- OE6.4: Name the different planning and management existing models, describing the new liberalization situation of the electrical national market.

**Learning time:** 6h
- Theory classes: 3h
- Practical classes: 1h
- Self study: 2h
<table>
<thead>
<tr>
<th>7. Energy savings. Coogeneration</th>
<th>Learning time: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 3h</td>
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</tbody>
</table>

**Description:**
Efficiency, energy-saving measures, cogeneration.

**Related activities:**
A1, A2, A3, A5, A6

**Specific objectives:**
OE7.1: Define the concept of the value of the energy
OE7.2: Number the optimization criteria of the industrial energy consumption, explaining some examples.
OE7.3: Describe the basis of cogeneration and justify its interest from an energy-saving point of view.
OE7.4: Solve practical exercises about the cogeneration plants and about the analysis of investment profitability in energy-saving.
### Planning of activities

#### A1. RESOLUTION OF EXERCISES

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 44h</th>
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</table>
| In groups of 4, the students solve the exercises set out by the professor during the duration of the classroom activity. At the end of each class session group, the obtained results must be handed in to the professor. In following days, the Professor will return the corrected exercises to the students, indicating the most important errors. Sometimes, each group will have to finish a part of the exercise out of the classroom and hand it in on the corresponding date. | Laboratory classes: 28h  
Self study: 16h |
| Support materials: | |
| Exercises handed in by the professor, bibliographic material of the students, calculator and computer. | |
| Descriptions of the assignments due and their relation to the assessment: | |
| Answers to the proposed exercises | |
| Specific objectives: | |

#### A2. THEORY CLASSES

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 40h</th>
</tr>
</thead>
</table>
| The professor explains during a lecture the basic concepts of the dealt topics. The theory concepts are built up with numeric exercises. | Laboratory classes: 24h  
Self study: 16h |
| Support materials: | |
| Presentations of the professor, collection of exercises, calculator and computer. | |
| Descriptions of the assignments due and their relation to the assessment: | |
| Additional documentation | |
| Specific objectives: | |
| All | |

#### A3. SEMINAR

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>An expert of the industrial sector or a renowned investigator exposes an actual topic related to the theme of the subject.</td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>Support materials:</td>
<td></td>
</tr>
<tr>
<td>Presentation of the speaker, computing material</td>
<td></td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td></td>
</tr>
<tr>
<td>A test with questions about the exposed topic which the student must answer the last 10 minutes of the session.</td>
<td></td>
</tr>
<tr>
<td>Specific objectives:</td>
<td></td>
</tr>
<tr>
<td>OE3.3, OE5.1, OE7.2</td>
<td></td>
</tr>
</tbody>
</table>
### A4. SIMULATOR OF A NUCLEAR PLANT

<table>
<thead>
<tr>
<th>Description:</th>
<th>Use of a simulator of a nuclear plant to explain some basic concepts about the operation and functioning of a nuclear plant and the principles of nuclear safety.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support materials:</td>
<td>RELAP simulation code adapted to the teaching, computer and projector.</td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td>Each student must answer to a test of 5 questions during the last 10 minutes of the session.</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>OE4.6</td>
</tr>
<tr>
<td>Hours:</td>
<td>2h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>2h</td>
</tr>
</tbody>
</table>

### A5. PARTIAL EXAM

<table>
<thead>
<tr>
<th>Description:</th>
<th>Exam of the units from 1 to 4. It consists of two parts valued individually. A part is a test and the other part one or some numerical exercises. Each student can solve the part of the exercises with its own bibliographic material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support materials:</td>
<td>Exam, documentation of each student.</td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td>Solved exam</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>Objectives topics 1 to 4</td>
</tr>
<tr>
<td>Hours:</td>
<td>10h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>8h</td>
</tr>
</tbody>
</table>

### A6. FINAL EXAM

<table>
<thead>
<tr>
<th>Description:</th>
<th>Exam of all the topics dealt during the course. Just as the partial exam, it consists of two parts valued individually. A part is a test and the other part one or some numerical exercises. Each student can solve the part of the exercises with its own bibliographic material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support materials:</td>
<td>Exam, documentation of each student.</td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td>Solved exam</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>All</td>
</tr>
<tr>
<td>Hours:</td>
<td>15h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>3h</td>
</tr>
<tr>
<td>Self study:</td>
<td>12h</td>
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</table>
Qualification system

IE1, IE3, IE4
The final grade will be calculated from the results of the following qualifications:
Mid-semester test (N1)
- Evaluation of the course activities (NC)
- Final exam at the end of the semester (N2)
The final grade (NF) will be calculated as the maximum value of the following options:
NFA = 0, 2 \cdot N1 + 0, 2 \cdot NC + 0, 6 \cdot N2
NFB = N2
NF = Max (NFA, NFB)

Rules to carry out the

Regulations for carrying out activities

The midterm and final exam consist of two parts. The first part corresponds to a test. The second part consists of an examination of problems. In each exam the test is worth a 40% and the problem a 60%.

Bibliography

Basic:


Complementary:


Others resources: