# 240IEN21 - Nuclear Power Plants

**Coordinating unit:** 240 - ETSEIB - Barcelona School of Industrial Engineering  
**Teaching unit:** 748 - FIS - Department of Physics  
**Academic year:** 2019  
**Degree:** MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)  
**ECTS credits:** 4.5  
**Teaching languages:** Catalan

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## Teaching staff

**Coordinator:** M. DEL CARMEN PRETEL SANCHEZ  
**Others:** Pretel Sanchez, M. Del Carmen  
Suarez Cambra, Daniel  
Freixa Terradas, Jordi

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## Opening hours

**Timetable:** To be defined:  
carme.pretel@upc.edu  
daniel.suarez.cambra@upc.edu  
jordi.freixa-terradas@upc.edu

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## Degree competences to which the subject contributes

**Specific:**  
CEMEI01. Knowledge and ability to analyse and design the generation, transport and distribution systems in electric energy.  
CEMEI17. Ability on the design, manufacturing, construction and operation of industrial plants.

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## Learning objectives of the subject

**General objective:**  
To show the technical and safety criteria applied to the design, construction, operation and dismantling of nuclear power plants. The basic aspects concerning the technology of structures, systems and components of an NPP, as well as its management are presented.

**Specific objectives:**  
To present the engineering areas involved in the project, construction and operation of nuclear power plants.  
To remark the most important functions of the main structures, systems and components on an NPP.  
To remark the importance of the administrative and technical methods used to verify safety in complex energy facilities, like nuclear power plants.  
To remark the safety culture concept and the human factor in the operation of nuclear power plants.
## Study load

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

| **Introduction to nuclear energy. Basic concepts.** | **Learning time:** 2h  
| Theory classes: 2h |

**Description:**  
content english

| **Elements of the nuclear reactor.** | **Learning time:** 1h 30m  
| Theory classes: 1h 30m |

**Description:**  
Basic elements of a nuclear reactor.  
**Specific objectives:**  
To present the basic elements of a nuclear fission reactor as a source of heat and radioactivity.

| **Development of Nuclear Power Plants.** | **Learning time:** 3h  
| Theory classes: 3h |

**Description:**  
Description of Generation II technologies (light water reactors, heavy water reactors, gas reactors). Generation III and generation IV technologies.  
**Specific objectives:**

| **Pressurized water reactors.** | **Learning time:** 4h 30m  
| Theory classes: 4h 30m |

**Description:**  
Primary System: Reactor vessel, internals, fuel element and control element, reactor coolant pumps, pressurizer.  
Secondary System: Stema generator, turbine, generator, condenser, the steam cycle. Tertiary system.  
**Specific objectives:**  
To present the technological characteristics of the PWR, the most used among NPPs.
### Auxiliary systems.

**Description:**
Description of the main auxiliary systems of a PWR: The chemical and volume control system. The boric acid addition system. Others.

**Learning time:** 1h 30m  
Theory classes: 1h 30m

### Safety systems and containment systems.

**Description:**
Introduction to the concept of nuclear safety. Description of the main safety systems of a PWR plant.

**Learning time:** 1h 30m  
Theory classes: 1h 30m

### Operation and control of a nuclear power plant.

**Description:**
Description of the automatic control systems of a PWR. Reactor reactivity feedback and human actions needed to operate a plant. Real operating experiences.

**Related activities:**
Simulator, practical session.

**Learning time:** 6h  
Theory classes: 6h

### Nuclear Safety.

**Description:**
Main concepts of nuclear safety. Defense in depth. Safety related design criteria. Descriptions of the main accidents occurred in NPPs. Description of the main thermohydraulic phenomena. DSA. PSA. Emergency Operating Procedures. Introduction to the international organizations.

**Related activities:**
Practical session

**Learning time:** 6h  
Theory classes: 6h
<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic design of a nuclear power plant.</td>
<td>1h 30m</td>
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<tr>
<td>Constructive design and construction.</td>
<td>Theory classes: 1h 30m</td>
</tr>
<tr>
<td>Description:</td>
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<tr>
<td>Introduction to the fundamentals on NPP design. Functions and design basis of systems, regulation, etc. Description of the main characteristics of the different stages of the design and construction of an NPP.</td>
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<tr>
<td>Nuclear fuel cycle.</td>
<td>3h</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
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<tr>
<td>Related activities:</td>
<td></td>
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<tr>
<td>Practical exercise session.</td>
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<tr>
<td>Specific objectives:</td>
<td></td>
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<tr>
<td>To remark the importance of the nuclear fuel resources and the obligations derived from its use (waste management)</td>
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<tr>
<td>Radiological Protection.</td>
<td>1h 30m</td>
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<tr>
<td>Description:</td>
<td></td>
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<tr>
<td>Main concepts related to the Radiological Protection.</td>
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<tr>
<td>Visit</td>
<td>4h 30m</td>
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<tr>
<td>Description:</td>
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<tr>
<td>Visit to Vandellós NPP</td>
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<tr>
<td>Learning time:</td>
<td></td>
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<tr>
<td>Theory classes:</td>
<td></td>
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<tr>
<td>Laboratory classes:</td>
<td>6h</td>
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<tr>
<td>Description:</td>
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</table>
Bibliography

Basic:

Complementary:

Others resources:
Hyperlink
Programa de formación práctica en el área de ingeniería nuclear mediante el simulador conceptual de central nuclear SI REP
E-prints UPC, http://hdl.handle.net/2117/17190 pag206