295557 - 295EQ033 - Risk and Safety at the Chemical Industry

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: English

Teaching staff
Coordinator: Pastor Ferrer, Elsa
Others: Planas Cuchi, Eulalia
Águeda Costafreda, Alba

Prior skills
Calculation, basic chemistry and thermodynamics

Degree competences to which the subject contributes

Specific:
- CEMUEQ-06. Design, build and implement methods, processes and facilities for the integral management of supplies and residues, solid, liquid and gaseous, in industries, with the capacity to assess their impacts and risks
- CEMUEQ-11. Direct and carry out verification, control of facilities, processes and products, as well as certifications, audits, verifications, tests and reports

General:
- CGMUEQ-06. Have the capacity to analyze and synthesize the continuous progress of products, processes, systems and services using safety, economic viability, quality and environmental management criteria
- CGMUEQ-07. Integrate knowledge and face the complexity of making judgments and decisions, based on incomplete or limited information, including reflections on the social and ethical responsibilities of professional practice

Transversal:
- 01 EIN. ENTREPRENEURSHIP AND INNOVATION: Knowing about and understanding how businesses are run and the sciences that govern their activity. Having the ability to understand labor laws and how planning, industrial and marketing strategies, quality and profits relate to each other.
- 05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
- 03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology
- Regular classes
- Hands-on workshops
- Project based learning
- Case studies
- Seminars

Learning objectives of the subject
After this course, the students should be able to identify the risks associated to smart chemical factories and related
installations; to evaluate the effects and consequences of severe accidents; to quantify and analyse technological risks.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>34h</th>
<th>22.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time: 150h</td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<td>Hours small group:</td>
<td>20h</td>
<td>13.33%</td>
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<td></td>
<td>Guided activities</td>
<td>0h</td>
<td>0.00%</td>
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<td></td>
<td>Self study:</td>
<td>96h</td>
<td>64.00%</td>
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## Content

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 4h</th>
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<tbody>
<tr>
<td>- Introduction to accidental environmental impact</td>
<td></td>
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<tr>
<td>- Risk: definition, types and metrics</td>
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<tr>
<td>- Risk tolerability</td>
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<tr>
<td>- Accidental scenarios at the chemical industry</td>
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<td>- Risk analysis structure</td>
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**Specific objectives:**
To understand the concept of risk. To have a general overview of the type of accidents that can occur at the chemical industry. To have a clear picture of the different activities involved in risk assessment and management at the chemical industry.

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 13h</th>
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<tbody>
<tr>
<td>- Hazards identification techniques: definition and types</td>
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<td>- Hazardous materials at the chemical industry</td>
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<tr>
<td>- Historical Analysis</td>
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<td>- Hazard &amp; Operability (HAZOP)</td>
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<td>- Hazard Identification (HAZID)</td>
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<tr>
<td>- Fault trees and event trees</td>
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**Related activities:**
Laboratory session 1: HAZOP workshop  
Laboratory session 2: Fault Trees and Event Trees workshop

**Specific objectives:**
To apply risk identification techniques. To identify and understand hazards associated to chemical substances.
### Source term

**Description:**
- Introduction to source terms calculations
- Flow of liquid through a hole in a tank
- Flow of gas or vapour through a hole
- Evaporation of a liquid from a pool
- General guidelines for source term calculations in QRA

**Specific objectives:**
To know the main source term models and apply those with simplified hypothesis

### Atmospheric dispersion

**Description:**
- Meteorological factors
- Dispersion modelling: release types and models type
- Gaussian models for neutral gases
- Heavy gas dispersion
- Consequence analysis
- Vulnerability

**Related activities:**
- Laboratory session 3: Introduction to Aloha software
- Laboratory session 4: Consequence and vulnerability analysis with Aloha software

**Specific objectives:**
To quantify the effects and consequences of toxic releases
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## Runaway reactions

**Description:**
- Historical analysis
- Exothermicity
- Risk analysis and process engineering
- Study cases

**Specific objectives:**
To understand the phenomena associated to runaway reactions. To know risk mitigation strategies in case of runaways.

**Learning time:** 3h  
Theory classes: 3h

## Fire Accidents

**Description:**
- Types of fires
- Flammability
- Modelling: solid body model, pool fires, boilover, jet fires, fireballs, flashfires
- Vulnerability

**Specific objectives:**
To quantify the effects and consequences of fires

**Learning time:** 4h  
Theory classes: 4h

## Explosions

**Description:**
- Types of explosions
- Blast and overpressure
- Explosions modelling: vapour cloud explosions, Bleves vessel explosions, dust explosions
- Vulnerability

**Related activities:**
Laboratory session 5: Case study - Analysis of an LNG road tanker real explosion

**Specific objectives:**
To quantify the effects and consequences of explosions

**Learning time:** 8h  
Theory classes: 6h  
Practical classes: 2h
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**Quantitative risk analysis**

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<td>Theory classes: 4h</td>
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<tr>
<td>Practical classes: 2h</td>
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**Description:**
- Introduction to QRA: aim of the study and phases
- Standards in QRA
- Examples of simplified and complex set-ups

**Related activities:**
Laboratory session 6: Simplified AQR of a real system

**Specific objectives:**
To know the objectives and different parts of QRA. To apply QRA standards in a real system.

**Risk mitigation strategies**

<table>
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<td>Theory classes: 4h</td>
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**Description:**
- Functional safety
- Prevention and protection safeguards
- LOPA analysis

**Specific objectives:**
To know the different functional safety strategies and layers of protection in chemical processes.

**Qualification system**

Partial exam 30%
Final exam 40%
Projects 30%

**Regulations for carrying out activities**

Exams are all mandatory and all the documentation of the subject is allowed to be used during the exams. All evaluation elements are mandatory.

Those students who meet the requirements set by the EEBE in their Assessment and Permanence Regulations will be able to access the re-assessment test (https://eebe.upc.edu/ca/estudis/estudis-de-master/documents-masters/assessment-and-academic-progress-regulations-for-bachelors-and-masters-degrees-at-the-eebe.pdf)
Bibliography

Basic:

