



# Course guide

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

Last modified: 09/08/2024

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 713 - EQ - Department of Chemical Engineering.

**Degree:** MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Compulsory subject).  
ERASMUS MUNDUS MASTER IN HYDROGEN SYSTEMS AND ENABLING TECHNOLOGIES (HYSET) (Syllabus 2024). (Optional subject).

**Academic year:** 2024    **ECTS Credits:** 6.0    **Languages:** English

### LECTURER

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**Coordinating lecturer:** ELSA PASTOR FERRER

**Others:** Primer quadrimestre:  
ELSA PASTOR FERRER - Grup: T1  
EULALIA PLANAS CUCHI - Grup: T1  
PASCALE VACCA - Grup: T1

### PRIOR SKILLS

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Calculus, basic chemistry and thermodynamics

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**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

**Generical:**

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

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

## LEARNING OBJECTIVES OF THE SUBJECT

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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.

## STUDY LOAD

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Type	Hours	Percentage
Hours large group	40,5	27.00
Hours small group	13,5	9.00
Self study	96,0	64.00

**Total learning time:** 150 h

## CONTENTS

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### Introduction to technological risk management

**Description:**

- Introduction to accidental environmental impact
- Risk: definition, types and metrics
- Risk tolerability
- Accidental scenarios at the chemical industry
- Risk analysis structure

**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.

**Full-or-part-time:** 4h

Theory classes: 4h



## Hazards identification

### Description:

- Hazards identification techniques: definition and types
- Hazardous materials at the chemical industry
- Historical Analysis
- Hazard & Operability (HAZOP)
- Hazard Identification (HAZID)
- Fault trees and event trees

### Specific objectives:

To apply risk identification techniques. To identify and understand hazards associated to chemical substances.

### Related activities:

Laboratory session 1: HAZOP workshop  
Laboratory session 2: Fault Trees and Event Trees workshop

### Full-or-part-time: 13h

Theory classes: 9h  
Practical classes: 4h

## 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

### Full-or-part-time: 2h

Theory classes: 2h

## Atmospheric dispersion

### Description:

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

### Specific objectives:

To quantify the effects and consequences of toxic releases

### Related activities:

Laboratory session 3: Introduction to Aloha software  
Laboratory session 4: Consequence and vulnerability analysis with Aloha software

### Full-or-part-time: 10h

Theory classes: 6h  
Practical classes: 4h



## 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.

**Full-or-part-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

**Full-or-part-time:** 4h

Theory classes: 4h

## Explosions

### Description:

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

### Specific objectives:

To quantify the effects and consequences of explosions

### Related activities:

Laboratory session 5: Case study – Analysis of an LNG road tanker real explosion

**Full-or-part-time:** 8h

Theory classes: 6h

Practical classes: 2h



### Quantitative risk analysis

**Description:**

- Introduction to QRA: aim of the study and phases
- Standards in QRA
- Examples of simplified and complex set-ups

**Specific objectives:**

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

**Related activities:**

Laboratory session 6: Simplified AQR of a real system

**Full-or-part-time:** 6h

Theory classes: 4h

Practical classes: 2h

### Risk mitigation strategies

**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.

**Full-or-part-time:** 4h

Theory classes: 4h

## GRADING SYSTEM

Partial exam 30%

Final exam 40%

Projects 30%

## EXAMINATION RULES.

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

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### Basic:

- Casal Fàbrega, Joaquim. Evaluation of the effects and consequences of major accidents in industrial plants [on line]. 2n ed. Amsterdam: Elsevier, [2018] [Consultation: 13/05/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5056836>. ISBN 9780444638922.
- Casal Fàbrega, Joaquim [et al.]. Análisis del riesgo en instalaciones industriales [on line]. Barcelona: Edicions UPC, 1999 [Consultation: 13/05/2020]. Available on: <http://hdl.handle.net/2099.3/36154>. ISBN 8483012278.
- Mannan, Sam. Lees' Loss prevention in the process industries : hazard identification, assessment and control. 4th ed. Oxford [etc.]: Elsevier, cop. 2012. ISBN 9780123971890.