Course guide
295557 - 295EQ033 - Risk and Safety in the Chemical Industry

Last modified: 02/10/2025

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: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: ELSA PASTOR FERRER

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

PRIOR SKILLS

Calculus,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

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.

LEARNING RESULTS

Knowledges:
K03. Demonstrate an understanding of the hydrogen value chain, including hydrogen production processes and technologies, hydrogen storage technologies, hydrogen transport/logistics/infrastructure, hydrogen end uses (stationary, mobility, industrial and residential, including fuel cells), hydrogen safety, codes and standards, and all socioeconomic issues related to the energy transition, partly driven by the use of hydrogen.
K02. Demonstrate in-depth knowledge of standards related to the safety of working with hydrogen, the integration of systems related to hydrogen technologies, and market potential.

Skills:
S01. Communicate effectively with others orally, in writing and graphically about learning, thought processes and decision making, and participate in discussions, using interpersonal skills such as active listening and empathy that support teamwork.
S02. Work in the field as well-trained, enthusiastic professionals with a broad multidisciplinary knowledge of hydrogen technologies and systems, educated in an international and multicultural environment to promote global cooperation in meeting the complex challenges of the energy transition.

Competences:
C02. Work as part of a multidisciplinary team, whether as a team member or in a leadership role, to contribute to the development of projects with pragmatism and a sense of responsibility, undertaking commitments with due regard to the resources available.
C05. Propose advanced scientific and technological solutions to complex industrial challenges in the field of energy, with a focus on the use of hydrogen as a vector.

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 sever accidents; to quantify and analyse technological risks.

STUDY LOAD

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

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 an 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

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.