COURSE: MATERIALS AND CORROSION

SUBJECT: Materials and corrosion
MODULE: Process Engineering and Product
PROGRAM: Master in Chemical Engineering

GENERAL FEATURES *

Type: ☐ Basic Training ☑ Compulsory ☐ Elective

☐ Master thesis, ☐ Internship

Duration: Semester **Semester / s:** 2
Number of ECTS credits: 3
Language / s: Spanish, Catalan and English

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION (The meaning of the course in relation to the program. Between 100 and 200 words.)

Corrosion is a major problem to which some industrial components are confronted, especially those dedicated to the transportation of fluids. This course is focused on the explanation of the different types of corrosion, analyzing the causes, listing the precautions and the remedies to correct them. It will also explain the different techniques that can be used to evaluate the corrosion behavior at the laboratory scale and also at the industrial scale.

COMPETENCES (Of course you put in relation to the skills pre-assigned in the field.)

- The student has knowledge and understanding of what constitutes a basis or an opportunity to be original by developing and/or applying ideas, often in a research context (**CB6**).
- The student can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to his/her field of study (**CB7**).
- The student can design, manage, execute and expose a project (**CG1**).
- The student can design products, processes, systems and services for the chemical industry as well as optimize other already developed, on the technological basis the various areas of Chemical Engineering, involving processes and transport phenomena, separation operations and reactor engineering, both chemical and nuclear, electrochemical or biochemical (**CE2**).
- The student has the ability to solve problems that are unfamiliar, incompletely defined, and have contradictory specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, being able to correct implementation and evaluating the different design solutions (**CE4**).
- As a professional, the student is able to manage and supervise all kinds of facilities, processes, systems and services in different industrial areas related to Chemical Engineering (**CE5**).

* These features should not be modified without the approval of the bodies responsible for academic higher-level structures (field, module and / or system).

- The student can design, build and implement methods, processes and systems for integrated management of supplies and wastes - solid, liquid and gaseous – in industries, being capable of assessing their impact and their risks (**CE6**).

PREREQUISITES * (Modules, materials, disciplines or expertise needed to track the subject. Contain subjects that must have been completed can be made.)

Students must be admitted at the master's degree program.

CONTENTS (Sections that make up the syllabus, to a second level of detail.)

1. Introduction: Definition of corrosion. Incidence of corrosion in industrial processes. Economic importance. The Hoar report. Bibliography.
2. Basic electrochemistry: Thermodynamic aspect of corrosion. Kinetic aspect of corrosion.
3. Different types of wet corrosion: Generalized Corrosion. Galvanic corrosion. Crevice corrosion. Pitting Corrosion. Stress Corrosion. Microbiologically Induced Corrosion. Morphology, propagation and prevention strategies will be discussed for each type of corrosion mechanism.
4. Atmospheric corrosion: influence of humidity and pollution. Mapping of corrosivity
5. High temperature corrosion: study of the different kinetics of corrosion at high temperature. Phenomena of passivation by different types of oxides. Decarburization of steels.
6. Corrosion prevention and control systems: systems in laboratory scale. Systems on industrial scale. Criteria for selecting a corrosion control system. Adequate selection of materials. Influence of the design. Action of the inhibitors. Anodic and cathodic protection. Coatings.
7. Materials selection: description of the main metallic and non-metallic materials used in industry: mechanical and chemical applications and price.
8. Discussion of real cases: diagnosing the causes the problem and possible solutions

METHODOLOGY

TRAINING ACTIVITIES * (Complete the table relating activities, workload in ECTS credits, and skills.)

Training Activities	ECTS	Competences
Sessions of exposition of concepts	0.75	CE2, CE4, CE5, CE6, CG1, CB6, CB7
Sessions solving exercises, problems and cases	0.30	CE2, CE4, CE5, CE6, CG1, CB6, CB7
Seminars	0.10	CE2, CE4, CE5, CE6, CG1, CB6, CB7
Practical work / laboratory	-	
Presentations	-	
Activities of personal study by students	1.70	CE2, CE4, CE5, CE6, CG1, CB6, CB7
Evaluation activities (exams, monitoring controls ...)	0.15	CE2, CE4, CE5, CE6, CG1, CB6, CB7
TOTAL	**3**	

TEACHING METHODOLOGY (Justifying the teaching methods used in relation to the competences and contents of the course. Between 100 and 200 words.)

In the Sessions of Exposition of Concepts/Lectures, the items included in the program are presented using classical teaching techniques: chalk-blackboard and PowerPoint presentations. In some cases, practical demonstrations are used to facilitate the understanding of specific concepts and to push the participation of the students. Dynamic lessons are encouraged in which the question-answer game will benefit not only the student (who asked the question), but also his/her classmates.

Problem Solving Sessions. Collections of corrosion cases will be used at class during the curse. Students must suggest analysis and l tests to propose a corrosion mechanism and suggest strategies to solve it or to minimize it. The goal of these activities is to help the student to understand, deepen and relate the concepts taught in the Sessions of Exposition of Concepts/Lectures. At class, common problems and classical exercises are also solved.

Individual or group consultations in the teacher's office: Students can ask their queries to the teacher individually or in groups of two to five people.

EVALUATION

ASSESSMENT SYSTEM * (Complete the table relating evaluation methods, competences and weight in the course grade.)

Evaluation Methods	%	Competences
Final Exam	40%	CE2, CE4, CE5, CE6 CG1, CB6, CB7
Follow-up Exams	-	
Monitoring activities	30%	CE2, CE4, CE5, CE6 CG1, CB6, CB7
Projects and presentations	20%	CE2, CE4, CE5, CE6 CG1, CB6, CB7
Practical work / laboratory	-	
Projects	-	
Host Student Evaluation	-	
Participation	10%	CE2, CE4, CE5, CE6 CG1, CB6, CB7

LEARNING OUTCOMES (Explanation of the embodiments that allow the student skills assessment, relating them to the skills and methods of assessment.)

Knowledge that gives the base or opportunity to be original in the development and / or application of ideas. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to apply the acquired knowledge. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to solve problems in new or unfamiliar environments related to their area of study. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to design and carry out a project. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to prepare engineering models, apply innovative methods in solving problems and use the appropriate computer applications for the control of processes and systems. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

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Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible resolution methods. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to select metallic materials to design processes, systems and services of the chemical and related industries, preventing possible corrosion problems. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to solve problems that are unfamiliar or incompletely defined in the field of metallic materials and corrosion science, evaluating the different design solutions. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Supervise facilities, processes, systems and services of the different industrial areas related to Chemical Engineering from the point of view of the metallic materials and prevent corrosion. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

Ability to select metallic materials to design, build and implement processes and facilities. (CB6, CB7, CG1, CE2, CE4, CE5 and CE6). Final exam, Follow-up activities, Projects and presentations, and Participation.

QUALIFICATION (Explanation of the computer system of the course grade.)

The grade of this course is obtained:

Final exam	40%
Monitoring activities	30%
Projects and presentations	20%
Participation	10%

If the grade of the final exam and/or the grade of the monitoring activities is less than 4, the final grade of the subject will be the lowest of the two. To pass the subject in the following calls, complementary monitoring activities and/or the final exam must be performed.

ASSESSMENT OF THE COMPETENCES (Define calculation expressions for each competence and the relevant evaluation methods.)

For the evaluation of the competences **CB6 and CB7** the final grade of the subject will be used as an indicator.

For the evaluation of the **CG1** competence, the final grade of the subject will be used as an indicator.

For the evaluation of the competences **CE2, CE4, CE5 and CE6**, the final grade of the subject will be used as an indicator.

BIBLIOGRAPHY (Recommended and accessible to students.)

- Mars G. Fontana. Corrosion Engineering. Ed. McGraw Hill (1980)
- Pierre Roberge. Corrosion Engineering: principles and practice. Ed. McGraw Hill (2008)
- Pierre Roberge. Handbook of Corrosion Engineering. Ed. McGraw Hill (2012)

DOCUMENT HISTORY

PREVIOUS CHANGES (You set the date and author / s, the most recent first)
21st of July 2016, Dr. Sergi Colominas
20th of July 2015, Dr. Sergi Colominas
08th of July 2014, Dr. Sergi Colominas
02nd of April 2014, Dr. Sergi Colominas

LAST REVISION (Indicate date and author / s.)
25th of February 2019, Dr. Sergi Colominas