Last update: 17-07-2018

300202 - QUI - Chemistry

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering

Teaching unit: 745 - EAB - Department of Agri-Food Engineering and Biotechnology

Academic year: 2018

Degree: BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERINGS/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING - NETWORK ENGINEERING (AGRUPACIÓ DE SIMULTANEÏTAT) (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

Prior skills

Upper secondary school chemistry.

Degree competences to which the subject contributes

Specific:

1. CE 4 AERO. Capacidad para comprender y aplicar los principios de conocimientos básicos de la química general, química orgánica e inorgánica y sus aplicaciones en la ingeniería. (CIN/308/2009, BOE 18.2.2009)

Generical:

4. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 1: Using instruments, equipment and software from the laboratories of general or basic use. Realising experiments and proposed practices and analyzing obtained results.

Transversal:

2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 1. Analyzing the world¿s situation critically and systemically, while taking an interdisciplinary approach to sustainability and adhering to the principles of sustainable human development. Recognizing the social and environmental implications of a particular professional activity.
3. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Teaching methodology

Directed learning in large groups consists of lectures in which the lecturer will present the main content of the subject and encourage students to participate in exercises and practical case studies, to ensure that all students take an active role in the learning process and consolidate their understanding of the theoretical material.
Directed learning in small groups consists of practical laboratory sessions, during which students will generally work in pairs. Practical sessions are designed to consolidate the theoretical concepts studied in lectures and to develop basic laboratory skills, as well as strengthening team work skills, a generic competence acquired during the course.
After most sessions, students will be set work to complete in their own time, which may include recommended reading or or questions and problem-solving exercises to be completed individually or in groups, which form the basis of the self-directed learning for this subject.

Last update: 17-07-2018

300202 - QUI - Chemistry

Learning objectives of the subject

On completion of Chemistry, students will be able to:
- Identify, formulate and solve problems that relate electronic and atomic structure to the chemical and physical properties of elements and different types of bonds. Identify the different crystal networks of solid materials. Define the possible imperfections of solid materials. Explain solid-solid diffusion and its dependence on temperature. Identify the industrial applications of solid-solid diffusion.
- Explain the process of corrosion and identify potentially corrosive materials on the basis of their chemical properties. Complete exercises and solve problems on corrosion and understand its importance in the aeronautics industry.
- Explain the process of combustion and identify potentially combustible substances on the basis of their chemical properties. Complete exercises and solve problems involving chemical kinetics and combustion models.

Study load

Total learning time: 150h	Hours large group:	26h	17.33%
	Hours medium group:	13h	8.67%
	Hours small group:	13h	8.67%
	Guided activities:	14h	9.33%
	Self study:	84h	56.00%

Last update: 17-07-2018

300202 - QUI - Chemistry

Content

Atomic Structure and Bonding

Learning time: 25h

Theory classes: 6h
Practical classes: 3h
Laboratory classes: 0h
Guided activities: 2h
Self study : 14h

Description:
1.1 Atomic numbers, electronic and atomic structure
1.2 Periodic properties
1.3 Types of bonds
1.4 Nuclear disintegration phenomena

Related activities:
Activity 1. Individual assessment tests. Test 1
Activity 2. Practical computer work
Activity 3. Directed Activities 5 and 6

Crystal Structure, Imperfections in Solid Materials and Diffusion

Learning time: 42h

Theory classes: 10h
Practical classes: 5h
Laboratory classes: 3h
Guided activities: 4h
Self study : 20h

Description:
2.1 Unit cell
2.2 Crystal systems and structures
2.3 Crystallographic directions and planes
2.4 Point defects
2.5 Imperfections
2.6 The diffusion phenomenon and mechanisms; Stationary and nonstationary diffusion
2.7 Temperature dependence of diffusion
2.8 Solid solutions; Phase diagrams; Alloys

Related activities:
Activity 1. Individual assessment tests. Test 1
Activity 2. Laboratory activities (computer room)
Activity 3. Directed Activities 7, 8 and 9

Last update: 17-07-2018

300202 - QUI - Chemistry

Electrochemistry	Learning time: 42h Theory classes: 5h Practical classes: 3h Laboratory classes: 5h Guided activities: 4h Self study : 25h

Description:
3.1 Redox reactions
3.2 Cell potential
3.3 Free energy and electrical work
3.4 Electrochemical process in aerospace fuel cells
3.5 Corrosion: Corrosive agents and antioxidants

Related activities:
Activity 1. Individual assessment tests. Test 2
Activity 2. Laboratory activities
Activity 3. Directed Activities 10 and 11

Combustion	Learning time: 41h Theory classes: 5h Practical classes: 2h Laboratory classes: 5h Guided activities: 4h Self study : 25h

Description:
4.1 Reaction mechanisms
4.2 Chemical kinetics
4.3 Chain reactions; Explosions
4.4 Temperature dependence of reaction rate
4.5 Combustion: Examples of combustion in aircraft motors

Related activities:
Activity 1. Individual assessment tests. Test 2
Activity 2. Laboratory activities
Activity 3. Directed Activities 12 and 13

Last update: 17-07-2018

300202 - QUI - Chemistry

Planning of activities

INDIVIDUAL ASSESSMENT TEST. TEST 1	Hours: 1h Theory classes: 1h Practical classes: 0h Laboratory classes: 0h Guided activities: 0h Self study: 0h

Description:
Short-answer questions and discursive questions on the theory content covered in class, laboratory sessions and computer work. Students will be tested on the topics Atomic Structure and Bonding and Crystal Structure, Imperfections in Solid Materials and Diffusion.

Support materials:
Tables and calculator.

Descriptions of the assignments due and their relation to the assessment:
Completion of the test by each student.
Lecturers' assessment of the directed and self-directed learning outcomes for each student.
The results will count towards the final mark.

Specific objectives:
The test will focus on students' knowledge of the following points:
a) The periodic properties of the elements and their associated macroscopic properties.
b) The characteristics of different types of bonds and their associated macroscopic properties.
c) The parameters for defining a crystallographic structure and the different crystal networks.
d) The characteristics of diffusion mechanisms and their industrial applications.
e) The characteristics of different types of imperfections in solid materials and their industrial applications and effects.

INDIVIDUAL ASSESSMENT TEST. TEST 2	Hours: 1h Theory classes: 1h Practical classes: 0h Laboratory classes: 0h Guided activities: 0h Self study: 0h

Description:
Short-answer questions and discursive questions on the theory content covered in class, laboratory sessions and computer work. Students will be tested on the topics Electrochemistry and Combustion.

Support materials:
Short-answer questions and discursive questions on the theory content covered in class, laboratory sessions and computer work. Students will be tested on the topics Electrochemistry and Combustion.

Descriptions of the assignments due and their relation to the assessment:
Completion of the test by each student.
Lecturers' assessment of the directed and self-directed learning outcomes for each student.
The results will count towards the final mark.

300202 - QUI - Chemistry

Specific objectives:
The test will focus on students' knowledge of the following points:
a) The concepts of free energy and electrical work and their relation to electrochemical potential.
b) The most important electrochemical processes in aerospace fuel cells.
c) The most corrosive agents and the main antioxidant elements and/or products.
d) The combustion mechanism at the molecular level and the explosion mechanism.
e) The theoretical and practical aspects of the temperature dependence of chemical reaction rates.

LABORATORY	Hours: 28h Theory classes: 0h Practical classes: 0h Laboratory classes: 10h Guided activities: 0h Self study: 18h

Description:
Two-hour practical laboratory sessions. Attendance of all laboratory sessions is compulsory. Students will work in pairs.
Laboratory work focuses on the practical application of the material covered in Electrochemistry and Combustion.

Support materials:
Required materials and reagents.
Detailed description of each activity and accompanying questions.

Descriptions of the assignments due and their relation to the assessment:
Lecturers' assessment of the directed learning outcomes for each student.
The results will count towards the overall mark for practical activities. Students must submit a report on each practical activity for assessment. The combined results will count for 10% of the final mark.

Specific objectives:
At the end of the series of practical sessions, students will be able to:
- carry out laboratory work in compliance with environmental and safety guidelines;
- understand the importance of organisation in laboratory work;
- handle laboratory material and chemical samples correctly;
- use laboratory equipment correctly;
- assess the value of their own results and compare them with the work of other groups;
- identify free energy and electrical work in an electrochemical process in practical cases;
- recognise the most corrosive agents and the main antioxidant elements and/or products;
- carry out redox reactions and monitor the main parameters;
- use controlled laboratory reactions to infer the temperature dependence of the rate of chemical reactions;
- carry out controlled combustions and monitor the main parameters.

PRACTICAL COMPUTER WORK	Hours: 6h Theory classes: 0h Practical classes: 0h Laboratory classes: 3h Guided activities: 0h Self study: 3h

300202 - QUI - Chemistry

Description:
Two-hour practical sessions in a computer room. Attendance of all computer-room sessions is compulsory. Students work individually.
Computer Work focuses on the practical application of the material covered in Atomic Structure and Bonding and Crystal Structure, Imperfections in Solid Materials and Diffusion.

Support materials:
Description of practical activities and computer per student.

Descriptions of the assignments due and their relation to the assessment:
Lecturers' assessment of the directed learning outcomes for each student.
The results will count towards the overall mark for practical activities. Students must submit a report on each practical activity for assessment. The combined results will count for 10% of the final mark.

Specific objectives:
At the end of the series of practical sessions, students will be able to:
- assess the potential and/or limitations of the mathematical models used to work with different crystal networks and to study diffusion phenomena;
- assess the value of their own results and compare them with the work of their classmates;
- recognise the characteristics of different types of bonds and infer the associated macroscopic properties;
- identify the parameters for defining a crystallographic structure and the different crystal networks;
- understand the characteristics of diffusion mechanisms;
- characterise the different types of imperfections in solid materials.

ACTIVITY 5: PERIODIC PROPERTIES OF CHEMICAL ELEMENTS

Hours: 1h
Guided activities: 1h

Description:
Groups of 10 students will infer the period properties of different elements on the basis of their positions in the periodic table. This activity will be carried out in a cooperative learning room.

Support materials:
Periodic table of the elements.

Descriptions of the assignments due and their relation to the assessment:
Students will present reasoned explanations of the relationships between the periodic properties of the elements, the position of each element in the periodic table, and the macroscopic characteristics associated with these properties. Proportion of final mark: 2%.

Specific objectives:
Establish the relationship between the periodic properties of an element and its electronic configuration.

ACTIVITY 6: CHEMICAL BONDING

Hours: 1h
Guided activities: 1h

Description:
Groups of 10 students will discuss the potential chemical bonds and interactions of different elements on the basis of their position in the periodic table. This activity will be carried out in a cooperative learning room.

Support materials:
Periodic table of the elements. Three-dimensional molecular models.

300202 - QUI - Chemistry

Descriptions of the assignments due and their relation to the assessment:
Students will present reasoned explanations of the relationships between the periodic properties of the elements, the position of each element in the periodic table, and the macroscopic characteristics associated with these properties at the level of bonding and electrostatic interaction between elements. Proportion of final mark: 2%.

Specific objectives:
Predict the types of bonds and chemical reactions an element can form on the basis of its periodic properties.

ACTIVITY 7: CRYSTAL STRUCTURE

Description:
Groups of 10 students will construct three-dimensional models of the most representative unit cells. This activity will be carried out in a cooperative learning room.

Support materials:
Three-dimensional molecular models.

Descriptions of the assignments due and their relation to the assessment:
Students will produce a short assignment describing the different types of unit cells and the most important crystallographic elements.

Specific objectives:
Students will consolidate their knowledge of crystallographic unit cells and identify crystallographic elements in 3D models.

ACTIVITY 8: SOLID-SOLID DIFFUSION

Hours: 1h
Guided activities: 1h

Description:
Using the results of the previous activity, groups of 10 students will produce graphic representations of point defects and imperfections in crystal networks. This activity will be carried out in a cooperative learning room.

Support materials:
Three-dimensional molecular models.

Descriptions of the assignments due and their relation to the assessment:
Students will produce a short assignment describing point defects and the most important types of crystal imperfections, highlighting their potential industrial applications and implications.

Specific objectives:
Students will consolidate their knowledge of crystal imperfections and point defects and reproduce examples in 3D models.

ACTIVITY 9: DIFFUSION IN SOLIDS

Hours: 2h
Guided activities: 2h

Description:
Groups of 10 students will complete and discuss exercises and specific problems involving solid-solid diffusion and its dependence on temperature. This activity will be carried out in a cooperative learning room.

Support materials:
Descriptions of the exercises and problems in digital and paper format.

300202 - QUI - Chemistry

Descriptions of the assignments due and their relation to the assessment:
Students will present their solutions to the exercises and problems. Proportion of final mark: 2%.

Specific objectives:
Students will consolidate their knowledge of diffusion in solids and the effect of temperature on this phenomenon.

ACTIVITY 11: PRACTICAL STUDY OF CORROSION PHENOMENA

Hours: 2h
Guided activities: 2h

Description:
Groups of 20 students will discuss and assess the results of practical sessions on redox experiments. Laboratory results will be used as the basis for discussion of the effects of corrosion and the most important industrial effects of this phenomenon. This activity will be carried out in a cooperative learning room.

Support materials:
Results of the practical sessions carried out by all groups.

Specific objectives:
Students will compare their results with the work of other groups, as well as submitting their data to statistical processing. Guidance will be provided on how to write the reports on practical sessions.

ACTIVITY 12: COMBUSTION AND EXPLOSION

Hours: 2h
Guided activities: 2h

Description:
Groups of 10 students will complete and discuss exercises and specific problems involving different combustion, explosion and chemical kinetic reactions. This activity will be carried out in a cooperative learning room.

Support materials:
Descriptions of the exercises and problems in digital and paper format.

Descriptions of the assignments due and their relation to the assessment:
Students will present their solutions to the exercises and problems. Proportion of final mark: 2%.

Specific objectives:
The teaching staff will assess students' understanding of combustion reactions and explosion mechanisms and their industrial applications in the aerospace sector.

ACTIVITY 13: PRACTICAL STUDY OF COMBUSTION

Hours: 2h
Guided activities: 2h

Description:
Groups of 20 students will discuss and assess the results of practical sessions on combustion and chemical kinetics experiments. Laboratory results will be used as the basis for discussion of the main industrial applications. This activity will be carried out in a cooperative learning room.

Support materials:
Results of the practical sessions carried out by all groups.

300202 - QUI - Chemistry

Specific objectives:
Students will compare their results with the work of other groups, as well as submitting their data to statistical processing. Guidance will be provided on how to write the reports on practical sessions.

ACTIVITY 10: REDOX REACTIONS	Hours: 2h Guided activities: 2h

Description:
Groups of 10 students will complete and discuss exercises and specific problems involving different redox reactions.
This activity will be carried out in a cooperative learning room.

Support materials:
Descriptions of the exercises and problems in digital and paper format.

Descriptions of the assignments due and their relation to the assessment:
Students will present their solutions to the exercises and problems. Proportion of final mark: 2%.

Specific objectives:
The teaching staff will assess students' understanding and practical handling of redox reaction mechanisms.

Qualification system

The final mark for this subject will be calculated from:
Tests: 20% (10% each)
Mid-semester examination: 20%
Final examination: 30%
Laboratory sessions: 20%
Directed activities: 10%

Regulations for carrying out activities

Students must bring the description of practical activities to all laboratory sessions and comply with health and safety regulations. Attendance of all laboratory sessions is compulsory. Failure to attend one or more sessions will result in the award of a mark of 0 (zero) for the corresponding report.
Students will carry out all practical laboratory work in pairs. Practical computer work must be completed individually.

300202 - QUI - Chemistry

Bibliography

Basic:

Chang, R. Fundamentos de química. McGraw-Hill, 2011. ISBN 9786071505415.

Pando García-Pumarino, Concepción; Iza Cabo, Nerea; Petrucci, Ralph H. Química general : principios y aplicaciones modernas. 10a ed. Madrid [etc.]: Pearson Prentice Hall, 2011. ISBN 9788483226803.

Smith, William F.; Hashemi, Javad; Nagore Cázares, Gabriel. Fundamentos de la ciencia e ingeniería de materiales. 4a ed. México [etc.]: McGraw-Hill, 2006. ISBN 9701056388.

Callister, William D.; Rethwisch, David G. Materials science and engineering : an introduction. 7th ed. New York [etc.]: John Wiley & Sons, 2007. ISBN 0471736961.

Complementary:

Xercavins, Josep. Desarrollo sostenible [on line]. Barcelona: Edicions UPC, 2005Available on: <http://hdl.handle.net/2099.3/36752>. ISBN 8483018055.

Mulder, Karel. Desarrollo sostenible para ingenieros [on line]. Barcelona: Edicions UPC, 2007Available on: <http://hdl.handle.net/2099.3/36831>. ISBN 9788483018927.