

# Course guide

## 220082 - Q1 - Chemistry I

**Last modified:** 19/04/2023

**Unit in charge:** Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 713 - EQ - Department of Chemical Engineering.

**Degree:** BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Catalan, Spanish

### LECTURER

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**Coordinating lecturer:** JORGE MACANÁS DE BENITO

**Others:** Gemma Cervantes Torre-Marín  
Xavier Cañavate Ávila  
Francesc Torrades Carné  
Josep Maria Dagà Montmany  
Margarita Morillo Cazorla  
Helena Matabosch Coromina  
Pol Fernández González

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

**Transversal:**

CT02 N1. Sustainability and social commitment - Level 1. Analysing 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.

CT05 N1. Effective use of information resources - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

### TEACHING METHODOLOGY

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The subject is organized in:

- i) Classes in large groups. In these classes the theoretical contents are developed. The expository model that the teacher deems appropriate to achieve the set objectives is used.
- ii) Classes in medium groups. In these classes the theoretical knowledge explained in theory class or acquired by the student in his / her autonomous learning is applied to problem solving and practical examples.
- iii) Small group classes. In these classes the laboratory practices corresponding to the subject will be carried out: the student makes contact with the chemical laboratory and with the experimental methodology. This class format will also be used to develop guided activities.

The ATENEA platform will be used as a support tool which will include: information and scheduling of activities, assessments, etc. and various learning materials. It will also serve students to make submissions, questions, comments and suggestions regarding the contents of the subject and their learning.

## LEARNING OBJECTIVES OF THE SUBJECT

Consolidate and acquire the necessary chemical knowledge to follow the studies of Industrial Engineering.

At the end of the course the student must be able to:

- Identify the chemical reaction and perform stoichiometric calculations correctly.
- Know the chemical elements and their properties.
- Understand the different types of chemical bonds.
- Understand, from the chemical bond, the formation of molecules and their properties.
- Relate the structure of molecules to intermolecular forces and the properties of matter.
- Describe the states of matter.
- Understand and apply concepts related to the speed of a chemical reaction.
- Understand and know how to apply the concept of chemical equilibrium, as well as the factors that affect it.
- Have knowledge of the most important organic compounds.
- Relate and apply theoretical concepts both in solving numerical problems and in carrying out laboratory practices.
- Provide the tools so that students are able to search for information, to select it, to reflect on it, creating their own criteria and opinions.
- Recognize chemistry as an experimental science and establish knowledge based on experimentation.
- Understand the impact of chemistry on the environment and sustainable development.

## STUDY LOAD

Type	Hours	Percentage
Hours medium group	14,0	9.33
Hours small group	14,0	9.33
Self study	90,0	60.00
Hours large group	32,0	21.33

**Total learning time:** 150 h

## CONTENTS

### 1. INTRODUCTORY CHEMISTRY

#### Description:

1.1 Pure substances: elements and compounds. Solutions: description. Type. Concentration unit.

1.2 Chemical reactions: types, the chemical equation, stoichiometric calculations.

#### Related activities:

Theory classes, problems and practices.

Activity 6 will be carried out to assess learning related to inorganic formulation, equalization of reactions and basic stoichiometric calculations. This activity can be done as a one-off written test or as a set of continuous assessment tests.

#### Full-or-part-time: 44h

Theory classes: 6h

Practical classes: 3h

Laboratory classes: 7h

Self study : 28h



## 2. THE STRUCTURE OF ATOMS. PERIODIC TABLE OF THE ELEMENTS

### Description:

- 2.1 Particles and atomic models
- 2.2 Principles of quantum chemistry. Schrödinger equation. Atomic orbitals and quantum numbers
- 2.3 Polyelectronic atoms: electronic configuration. Periodic table: properties

### Related activities:

Theory classes, problems and practices

### Full-or-part-time: 20h

Theory classes: 4h  
Practical classes: 1h  
Laboratory classes: 3h  
Self study : 12h

## 3. CHEMICAL BONDING

### Description:

- 3.1 Type of chemical bond. Type of substances.
- 3.2 Molecular substances. Molecular parameters and properties (bond order, bond length, bond angles, geometry, polarity).
- 3.3 Covalent bond theories: VSEPR, Valence Bond Theory (VTE), VSEPR, Hybridization and Molecular Orbitals Theory (MOT)
- 3.4 Intermolecular forces.

### Related activities:

Classes of theory, problems and practices.

### Full-or-part-time: 15h

Theory classes: 5h  
Practical classes: 1h  
Self study : 9h

## 4. STATES OF MATTER: GASES, LIQUIDS AND SOLIDS

### Description:

- 4.1 State gas: Lleis fonamentals dels gasos. State equation of an ideal gas.
- 4.2 Kinetic theory of ideal gases: Relationship between kinetic energy and temperature. Root mean square velocity of a gas. Distribution of the velocity of gas particles.
- 4.3 Real gases: Deviation from the ideal behavior. Van der Waals Forces. Van der Waals equation. Gas liquefaction.
- 4.4 Liquid estate: Intermolecular forces in liquids. Properties of liquids: vapor pressure, viscosity, surface tension.
- 4.5 Solid estate: Types of solids (molecular, ionic, covalent and metallic) and their properties. Metallic bond.
- 4.6 Phase diagrams

### Related activities:

Classes of theory, problems and practices.

### Full-or-part-time: 24h

Theory classes: 7h  
Practical classes: 3h  
Self study : 14h



## 5. CHEMICAL KINETICS AND CHEMICAL EQUILIBRIUM

### Description:

5.1 Reaction rate. Law of velocity and reaction orders Arrhenius equation. Catalysis. Collision theory. Transition state theory. Reaction mechanisms.

5.2 Chemical equilibrium. Homogeneous and heterogeneous chemical equilibria. Balance constant. Reaction quotient. Degree of dissociation. Factors affecting the chemical equilibrium.

### Related activities:

Classes of theory, problems and practices.

### Full-or-part-time: 40h

Theory classes: 7h

Practical classes: 6h

Laboratory classes: 4h

Self study : 23h

## 6. ORGANIC CHEMISTRY

### Description:

6.1 Organic compounds and their structures.

6.2 Main functional groups and their nomenclature

### Related activities:

Classes of theory, problems and practices.

### Full-or-part-time: 7h

Theory classes: 3h

Self study : 4h

## ACTIVITIES

### ACTIVITY 1. THEORY CLASSES

#### Description:

Methodology: Large group

Exposition of the contents of the subject following a participatory expository class model.

The subject has been organized into thematic areas that configure the chapters presented in the contents of this guide.

#### Material:

Basic and specific bibliography

Teacher's notes (ATENEA)

#### Delivery:

This activity is evaluated, together with Activity 2, with the completion of two written tests: Partial Exam (Activity 4) and Final Exam (Activity 5) following the ESEIAAT schedule, as well as the completion of some complementary evaluation activity that is will be finalized at the beginning of the academic year.

### Full-or-part-time: 73h

Theory classes: 27h

Self study: 46h



## ACTIVITY 2. EXERCISE CLASSES

### Description:

Methodology: Medium group

A selection of questions, exercises and problems that must be solved is provided to students. The work carried out by the students is monitored, solving any doubt and discussing the different approaches or solutions to the posed exercises.

### Specific objectives:

At the end of these classes, the student must be able to apply the theoretical knowledge of the subject in the application of practical cases.

You must also be able to:

- Analyze the problem: understand the statement. Answer questions from: What data with woman, what do you ask me?
- Determine the principles and relationships that unite data with the unknown.
- Develop a plan to solve the problem.
- Solve the problem: Know how to use known information, equations and relationships to isolate the unknowns.
- Follow the rules and instructions about signs, units and significant numbers.
- Check the solution: see if the answer is logical and reasonable. Check that both the units and the number of significant figures are correct.

### Material:

Basic and specific bibliography.

Teacher's notes (ATENEA)

### Delivery:

This activity is evaluated, together with Activity 1, with the completion of two written tests: Partial Exam (Activity 4) and Final Exam (Activity 5) following the ESEIAAT schedule, as well as the completion of some complementary evaluation activity that is will be finalized at the beginning of the academic year.

**Full-or-part-time:** 33h

Practical classes: 14h

Self study: 19h

### ACTIVITY 3. CHEMISTRY LABORATORY

**Description:**

This activity consists of carrying out between 4 and 6 practices of chemical experimentation in the laboratory that will be carried out in pairs.

Student work includes:

- Pre-laboratory learning: preparation of the activity by reading the documentation and answering related questions. This work is done by the students as autonomous work.
- Practical execution of the experimentation. The practice will take place in the chemistry laboratory with a duration of 2 hours.
- Post-laboratory learning. Analysis of the results collected in the laboratory notebook. Reflection on practices. This work is done by the students as autonomous work.
- Debate of the experimental results.
- Final exam.

**Specific objectives:**

At the end of this activity, the student must be able to:

- Perform basic chemical laboratory operations.
- Acquire experimental skills.
- Know how to describe the experiments performed.

**Material:**

All the material and reagents needed for the experimental performance in the laboratory.  
Detailed scripts with experimental procedures and supporting documents.

**Delivery:**

Students must have an exclusive laboratory notebook that can be claimed for review and evaluation.

Students will have to answer questionnaires (physical or virtual) in relation to the contents and methodologies of the practices. Students must take a written test on the contents and methodologies of the practices that will be carried out either in the last week of classes or simultaneously in the Final Exam.

The weighting of the evaluation tests of the Laboratory Practices will be published at the beginning of the course and will always be equivalent to 20% of the final mark of the subject.

**Full-or-part-time:** 34h

Laboratory classes: 14h

Self study: 20h

### ACTIVITY 4. PARTIAL EXAM

**Specific objectives:**

Develop the knowledge acquired in the theoretical, practical and laboratory sessions and show the level of achievement achieved.

**Delivery:**

Fullfilled examination documents.

This activity is assessed as part of the N1P element of the overall assessment of the subject.

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

Theory classes: 2h



#### ACTIVITY 5. FINAL EXAM

**Description:**

Methodology: Large group

Development of the final exam of the subject.

**Specific objectives:**

Develop the knowledge acquired in the theoretical, practical and laboratory sessions and show the level of achievement achieved.

**Delivery:**

Fullfilled examination documents.

This activity is assessed as part of the N2P element of the overall assessment of the subject.

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

Theory classes: 2h

#### ACTIVITY 6. TEST OF FORMULATION, NOMENCLATURE (ORGANIC CHEMISTRY I) AND EQUILIBRIUM REACTIONS

**Description:**

Basic concepts of chemistry related to: inorganic formulation, equalization of reactions and stoichiometry that students will have to work on in autonomous learning and in the established face-to-face sessions are evaluated.

This activity can be done as a one-off written test or as a set of continuous assessment tests (depending on the particular planning of each semester).

**Specific objectives:**

At the end of the test, the student must be able to:

- Know the symbols and valences of the most common chemical elements
- Know how to identify families of inorganic chemical compounds
- Know how to formulate and name the most common chemical compounds.
- Know how to write and match chemical reactions.

**Material:**

Guidelines, bibliography and references on inorganic formulation, equalization of reactions and stoichiometry.

Bibliography and specific webography.

**Delivery:**

This activity has a value of 10% of the global mark of the subject.

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

Theory classes: 1h

Self study: 5h



## GRADING SYSTEM

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Global mark =  $NG = 0.20 \times N1P + 0.50 \times N2P + 0.20 \times NL + 0.10 \times NA$

where:

N1P corresponds to the qualification of the Partial Examination (and the complementary assessment activities, if applicable).

N2P corresponds to the qualification of the Final Exam (and the complementary assessment activities, if applicable).

NL corresponds to the qualification of Laboratory Practices (Activity 3 of this guide).

NA corresponds to the qualification in Activity 6 of this guide.

Unsatisfactory Partial Exam (N1P) results will lead to the Final Exam (N2P) for all students. NG \* will be calculated as follows:

$NG^* = 0.70 \times N2P + 0.20 \times NL + 0.10 \times NA$ .

If NG \* is higher than NG, NG \* will be the final grade of the subject.

If applicable, it will be possible to participate in a program of continuous assessment and support for students that can add up to 0.5 points to the final grade of the subject (without exceeding the maximum numerical value of 10 ).

## EXAMINATION RULES.

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The ESEIAAT Academic Regulations will be applied.

## BIBLIOGRAPHY

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### Basic:

- Whitten, Kenneth W. Química general. 5a ed. Madrid: McGraw-Hill, 1998. ISBN 8448113861.

- Chang, Raymond. Química [on line]. 13a ed. México: McGraw-Hill, 2020 [Consultation: 15/03/2023]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=10619](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10619). ISBN 9781456277161.

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- Peterson, W. R. Nomenclatura de las sustancias químicas [on line]. 4a ed. Barcelona, [etc.]: Reverté, cop. 2016 [Consultation: 14/11/2022]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5635463>. ISBN 9788429176087.

## RESOURCES

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### Audiovisual material:

- <https://zonavideo.upc.edu/>. Resource

### Hyperlink:

- <http://upcommons.upc.edu/video/handle/2099.2/1112>- <http://www.webelements.com>